Ministry of
Northern Development
and Mines
Ontario

Precambrian Geology

Yarrow and Doon Townships

with Emphasis on the Huronian Supergroup

Ontario Geological Survey
Report 277

R.M. Junnila

1990

CANADA ONTARIO

This project is part of the five-year Canada-Ontario 1985 Mineral Development Agreement (COMDA), a subsidiary agreement to the Economic and Regional Development Agreement (ERDA) signed by the governments of Canada and Ontario.

91-05490/

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ISSN 0704-2582
ISBN 0-7729-6787-3

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Publications Ontario
Main Floor, 880 Bay Street
Toronto, Ontario M7A 1N8

Canadian Cataloguing in Publication Data

Junnila, R. M. (Randy M.)

Precambrian geology, Yarrow and Doon townships, with emphasis on the Huronian Supergroup

(Ontario Geological Survey report, ISSN 0704-2582 ; 277)
ISBN 0-7729-6787-3

1. Geology--Ontario--Yarrow. 2. Geology--Ontario--Doon (Township). I. Ontario. Mines and Minerals Division. II. Ontario Geological Survey. III. Title. IV. Series.

QE191.J86 1990 557.13'144 C90-092521-3

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Parts of this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Junnila, R.M. 1990. Precambrian geology, Yarrow and Doon townships, with emphasis on the Huronian Supergroup; Ontario Geological Survey, Report 277, 33p.

Scientific Editors: B. Sifrer and G. Kendrick

Maracle-1000-90

Foreword

Before the current mapping was undertaken in 1987, only reconnaissance-level geologic information was available for Yarrow and Doon townships. The map area was believed to be underlain mainly by rocks of the Huronian Supergroup.

Geologic mapping of Yarrow and Doon townships was undertaken in 1987 by the Ontario Geological Survey as part of the Canada–Ontario Mineral Development Agreement (COMDA). This is part of an ongoing program to improve the geologic map coverage of the province in order to assist mineral exploration in poorly studied areas. In addition to geologic mapping, the COMDA program also requires that studies of surficial geology and metallic and nonmetallic mineral potential be made.

This area contains several inliers of Archean metavolcanic and metasedimentary rocks as well as the conglomerates and siltstones of the Proterozoic Gowganda Formation of the Huronian Supergroup. A lead-zinc mine was operated in Yarrow Township in the early 1950s; a barite mine is presently operating on Ministikon Lake.

Two former gold producers are located just outside the map area. Lithologic types and structures favourable for gold also occur in the map area and warrant investigation.

V.G. Milne

Director
Ontario Geological Survey

Contents

Abstract 2

Résumé 3

Introduction 4
- Location 4
- Access and Exposure 4
- Topography and Drainage 4
- Previous Geological Investigations 5
- Present Geological Survey 5
- Acknowledgments 6
- Mineral Exploration 6

General Geology 7
- Late Archean 7
  - Metavolcanic and Metasedimentary Rocks 7
    - Intermediate to Felsic Metavolcanic Rocks 7
    - Metasedimentary Rocks 8
  - Felsic Intrusive Rocks 9
    - Granitic Rocks and Gneisses 9
  - Intermediate Intrusive Rocks 11
    - Diorite 11
  - Mafic Intrusive Rocks 12
    - Matachewan Diabase 12
- Early Proterozoic 12
  - Huronian Supergroup 12
    - Cobalt Group 12
      - Gowganda Formation 12
        - Lower Gowganda Formation (Coleman Member) 13
        - Rock Descriptions 13
        - Depositional Environment 17
          - Introduction 17
          - Interpretations 20
          - Studies of the Lower Gowganda Formation (Coleman Member) Adjacent to the Map Area 20
  - Mafic Intrusive Rocks 20
    - Nipissing Intrusive Rocks 20
  - Cenozoic 21
    - Quaternary 21
      - Pleistocene and Recent 21

Structural Geology 22
- Folds 22
- Faults 22

Economic Geology 23
- Descriptions of Properties and Unclaimed Parcels of Explored Land 23
  - Bagdad Exploration Associates Limited 23
  - Barker Syndicate 23
  - Canadian Aero Mineral Surveys Limited 23
  - Extender Minerals of Canada Limited 23
  - L. Harvey 23
  - Laroma Midlothian Mines Ltd. 23

Maralgo Mines Ltd. 23
Matarrow Lead Mines Limited 24
Matarrow Mine 24
Schaus, R.B., Clark, D.L. and Shirriff, J.F. 24
The Coniagas Mines, Limited 24
Vandeventer Claims 24
Recommendations for Exploration 24
Archean Inliers 24
Huronian Supergroup 24
References 26
Appendix (Geochemical Analysis) 27

FIGURES

1. Location map 4
2. Generalized stratigraphic diagram of the Gowganda Formation 13
3. Sandstone classification diagram 18
4. Glaciomarine depositional model 19

PHOTOGRAPHS

1. Landscape view, Doon Township 5
2. Flow-top breccia in metavolcanic rocks 9
3. Banded iron formation 10
4. Photomicrograph of gneissic granodiorite 10
5. Deformed gneiss and mafic xenoliths 11
6. Mylonite 12
7. Granodiorite intruding mylonite 12
8. Photomicrograph of hornblende-rich granodiorite 13
9. Wacke clast, Gowganda Formation 14
10. Laminated siltstone and mudstone, Gowganda Formation 14
11. Ball-and-pillow structures, Gowganda Formation 15
12. Photomicrograph of dropstone in laminated siltstone and mudstone, Gowganda Formation 15
13. Granitic dropstone in laminated siltstone and mudstone, Gowganda Formation 16
14. Diamictite lens, Gowganda Formation 16
15. Photomicrograph of lithic arkose, Gowganda Formation 19

TABLES

1. Table of lithologic units 8
2. List of properties and unclaimed explored land 23

GEOLOGICAL MAP

Map 2546 – Precambrian geology, Yarrow and Doon townships ..... back pocket

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

Precambrian geology, Yarrow and Doon townships, with emphasis on the Huronian Supergroup

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Manuscript approved for publication by V.G. Milne, Director, August 11, 1988. Report published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

This report, based on a reconnaissance investigation, describes the geology of Yarrow and Doon townships. The emphasis of the report is on rocks of the Huronian Supergroup found in these townships. The map area covers 187 km² and is centred 11 km southwest of the town of Matachewan, in the District of Timiskaming.

The oldest rocks in the map area are Late Archean metavolcanic and metasedimentary rocks, which are exposed in three small inliers. The metavolcanic rocks consist of massive, pillowed and amygdaloidal mafic flows and massive, intermediate to felsic flows and tuffs. The metasedimentary rocks consist of banded chert-magnetite iron formation, diamictite, sandstone and siltstone. These rocks have been intruded by granodiorite and granite of the northwestern part of the Round Lake batholith. The rocks are typically gneissic and in one zone contain mafic xenoliths derived from pre-existing mafic volcanic or mafic intrusive rocks, or both. All the above rock types have been intruded by north-trending Matachewan diabase dikes.

Early Proterozoic sedimentary rocks of the Huronian Supergroup rest unconformably on the Late Archean rocks. They underlie most of the map area and consist of the Lower Gowganda Formation (Coleman Member) of the Cobalt Group. Basal strata range from laminated mudstone and siltstone and laminated mudstone with dropstones, to massive diamictite. The remainder of the succession, which is approximately 200 m thick, consists of interbedded sandstone, diamictite and minor amounts of siltstone. Soft-sediment deformation is common. The rocks are composed of glacial debris deposited subaqueously by debris and turbidity flows, and by ice-rafting. Deposition was controlled by a major ice sheet situated over a continental margin during a glacial regime.

Nipissing intrusive rocks are represented by isolated outcrops of diabase which have intruded the Gowganda Formation. The diabase has also been intruded along the Late Archean–Early Proterozoic unconformity.

A large part of the map area is mantled by Quaternary deposits of gravel and sand. Two parabolic sand dunes were observed on a sand plain in southwestern Doon Township.

The Archean metavolcanic and metasedimentary rocks, which are locally sheared, strike to the northeast, dip to the northwest, and exhibit a northeast-trending schistosity that dips to the southeast, except in the metavolcanic rocks in southern Doon Township where schistosity dips steeply northward. The felsic intrusive rocks of the Round Lake batholith exhibit a northeast-trending gneissosity that dips steeply to the northwest. Xenolith-bearing zones in the Round Lake batholith have been intensely deformed. Rocks of the Gowganda Formation strike to the northeast and dip gently to the southeast. Two major northeast-trending faults occur in the map area. Northeast- and northwest-trending joint sets are prominent in the Gowganda Formation. Local variations in strike and dip suggest postdepositional block faulting.

Gold prospecting activity has taken place in northern Yarrow Township; a lead mine was also briefly in production. This area lies to the south of the probable western extension of the Kirkland Lake–Larder Lake fault zone. At the time of writing, barite was being produced in western Yarrow Township.

The results of chemical analysis of the major rock types of the area are listed in the Appendix to this report.

Résumé

Ce rapport, basé sur un travail de reconnaissance, décrit la géologie des cantons de Yarrow et Doon. L'accent est mis sur les roches du Supergroupe de l'Huronien qui sont exposées dans ces cantons. La zone cartographiée couvre 187 km² et son centre se situe à 11 km au sud-ouest de la ville de Matachewan dans le district de Timiskaming.

Les roches les plus anciennes dans la zone cartographiée sont des roches métavolcaniques et métasédimentaires de l'Archéen supérieur qui apparaissent dans trois petites fenêtres. Les roches métavolcaniques sont composées de coulées mafiques massives, de coulées à coussinets et amygdalaires, ainsi que de coulées massives intermédiaires à felsiques et de tufs. Les roches métasédimentaires sont composées de formation de fer rubanée à chert-magnétite, de diamictite, de grès et de siltstone. Ces roches ont été intrudées par des granodiorites et granites dans la partie nord-ouest du batholite de Round Lake. Les roches sont typiquement gneissiques et dans une zone en particulier, elles contiennent des xénolites mafiques provenant des roches volcaniques ou intrusives mafiques pré-existantes, ou des deux. Les précédents types ont été intrudées par des dykes de diabase de Matachewan orientés vers le nord.

Les roches sédimentaires du Protérozoïque du Supergroupe de l'Huronien reposent de façon discordante sur des roches de l'Archéen supérieur. Elles affleurent dans la majeure partie de la zone cartographiée et constituent la partie inférieure de la Formation de Gowganda (Membre de Coleman) du Groupe de Cobalt. Les couches basales sont formées de mudstone laminé et de siltstone et des mudstones laminés avec des "dropstones" et de diamictite massive. Le reste de la succession d'une épaisseur d'environ 200 m, est composé de grès, diamictite et des quantités moindres de siltstone interstratifiés. Les structures de déformation syn-sédimentaires sont fréquentes. Les roches sont composées de débris glaciaires déposés dans un milieu sub-aquatique par des coulées boueuses, par des turbidites et par la dérive des glaces. Les dépôts ont été contrôlés par un glacier continental s'étendant en bordure de continent au cours d'une période glaciaire.

Les roches intrusives de Nipissing sont représentées par des affleurements isolés de diabase qui a intrudé la Formation de Gowganda. Des intrusions de diabase ont été mises en place aussi le long de la discordance séparant l'Archéen supérieur et le Protérozoïque inférieur.

Une grande partie du secteur cartographié est recouvert de dépôts de sable et gravier Quaternaires. Deux dunes paraboliques de sable ont été observées sur une plaine sabloneuse au sud-ouest du canton de Doon.

Les roches métavolcaniques et métasédimentaires archéennes, locallement faillées, sont orientées vers le nord-est avec un pendage vers le sud-ouest. Ces roches montrent une schistosité de direction nord-est avec un pendage vers le sud-est, à l'exception des roches métavolcaniques dans le sud du canton de Doon qui elles ont un pendage fortement incliné vers le nord. Les roches intrusives felsiques du batholite de Round Lake, montrent une gneissosité de direction nord-ouest Les zones à xénolites du batholite de Round Lake ont été fortement déformées. Les roches appartenant à la Formation de Gowganda sont orientées vers le nord-est avec un pendage faible vers le sud-est. Deux failles majeures d'orientation nord-est recoupent le secteur cartographié. Des systèmes de diaclases, de direction nord-est et nord-ouest, sont proéminents dans la Formation de Gowganda. Des variations locales dans l'orientation et le pendage suggèrent la formation de blocs faillés post-dépositionnelles.

Dans le nord du canton de Yarrow a pris place une activité de prospection pour l'or; dans le même canton une mine de plomb fut aussi exploité pour une courte période de temps. Cette région s'étend au sud de l'extension probable vers l'ouest de la zone faillée de Kirkland Lake–Larder Lake. Au cours de la réalisation de ce rapport, de la barytine était produite dans l'ouest du canton de Yarrow.

Les résultats des analyses de principaux types de roches affleurant dans la région sont reportés dans l'appendice de ce rapport.

Junnila, R.M. 1990. Precambrian geology, Yarrow and Doon townships, with emphasis on the Huronian Supergroup; Ontario Geological Survey, Report 277, 33p.

Introduction

Location

The Yarrow and Doon townships map area covers 187 km² and is located 1 km southwest of Matachewan, in the District of Timiskaming (Figure 1). The area is bounded by latitudes 47°50′30″N and 47°56′40″N and by longitudes 80°39′35″W and 80°55′00″W.

Access and Exposure

The town of Matachewan is located approximately 60 km southwest of Kirkland Lake and can be reached via Highway 66. Access to the map area is by a gravel road which branches southwest from Highway 566, 2 km west of Matachewan. This road passes to the west through northwestern Yarrow Township and central Doon Township and provides access to the site of the now defunct mill and open pit mine of United Asbestos Ltd. in Midlothian Township.

In Yarrow Township, a frequently used logging road leads south from the central road. The logging road, maintained by the Mitchell Logging Company, branches at Zigzag Lake. The eastern branch provides access to the Montreal River (Sisseney Lake) via a side road south of Hildreth Lake in Morel Township. The western branch of the logging road provides access to southwestern Yarrow Township and runs parallel to the West Montreal River (Mistinikon Lake) well into Van Hise Township.

In Doon Township, a gravel road branches north from the central road and joins Highway 566 in northern Bannockburn Township. Another road immediately west of Elmer Lake leads south and crosses a cleared and reforested area. West of Duncan Creek, a road traverses the cleared area and ends approximately 100 m north of Duncan Lake. During the field season, this road was blocked by a dismantled bridge 700 m to the south of the central road. The creek at this location can be crossed with an all-terrain vehicle. Numerous tracks and trails branch from the roads in both townships.

The metavolcanic and metasedimentary rocks, which exhibit little relief, are poorly exposed in Yarrow Township; in Doon Township they are exposed in the cleared area west of Duncan Creek. The felsic plutonic rocks in Yarrow Township are well exposed, especially in numerous clearings and along roadside exposures. The lowermost strata of the Gowganda Formation are poorly exposed, except in cleared areas and along roadcuts in central Doon Township. The remainder of the succession is well exposed in hills west of Sisseney Lake and east and west of Elmer Lake. Low water levels during the field season in 1987 enhanced shoreline exposures provided by the lakes and rivers of both townships.

Topography and Drainage

Topography in the map area is controlled by the nature of the geology. Areas underlain by Archean metavolcanic and metasedimentary rocks exhibit little relief. The base level in the area is 356 m above sea level. The Gowganda Formation forms hills and ridges with local relief of up to 200 m. The highest point in the map area is southwest of Elmer Lake, in Doon Township, where hills of the Gowganda Formation reach an elevation of

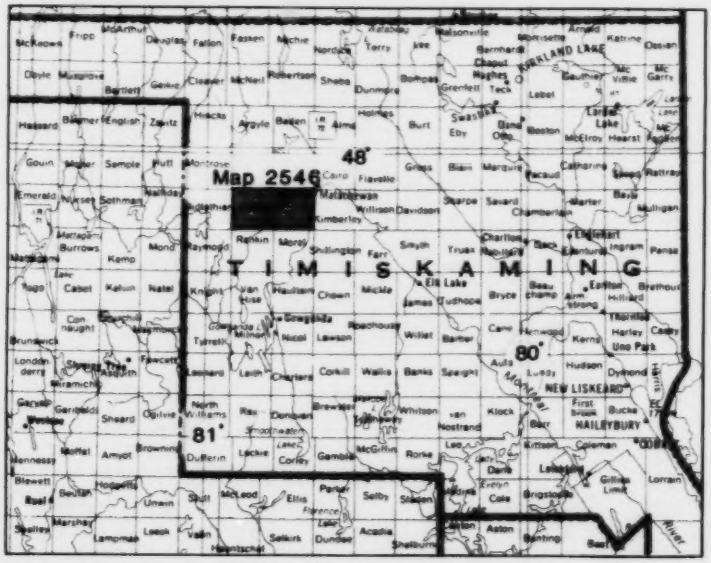

Figure 1. Key map showing location of the Yarrow and Doon townships map area, scale 1:1 584 000

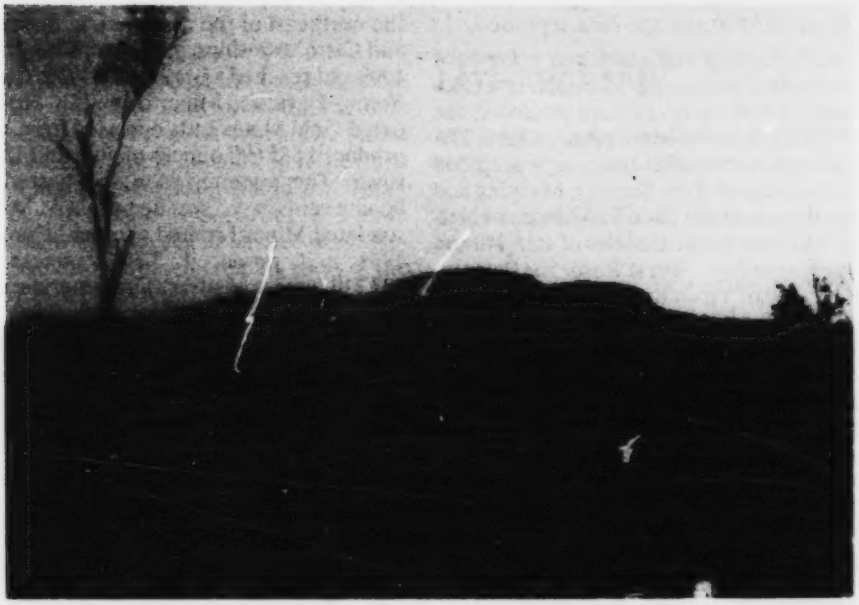

Photo 1. View looking southwest in Doon Township toward gently dipping strata of the Gowganda Formation. The hills lie on the southwest shore of Elmer Lake.

558 m above sea level. The gentle southeasterly dip of these strata forms a cuesta topography (Photo 1).

The height of land separating the watershed of the St. Lawrence River system from that of James Bay passes through Midlothian Township, immediately to the west of the map area. The West Montreal River flows northeastward through Doon and Yarrow townships where it broadens to form Mistinikon Lake. At "the Great Northern Bend" in Baden Township, the river is diverted southeastward away from the height of land. The Montreal River flows northeastward through Morel and Yarrow townships where it forms Sisseney Lake. The confluence of the two streams is 1 km south of Matachewan (Matachewan is the anglicized form of the Ojibway word "Madagewin" which means "where the rivers meet"). From here, the Montreal River flows southeastward to Lake Timiskaming.

Most of Doon Township and parts of Yarrow Township are covered by gravel and are well drained. The western part of Doon Township consists of a sand plain. Isolated swamps occur here along the flood plain of Duncan Creek and around the margin of Kame Lake.

Previous Geological Investigations

The first mapping in the vicinity was by Bell (1876) who described the geology along the shore of the Montreal and the West Montreal rivers. To the west, Burwash (1896) mapped along the Nipissing–Algoma survey line. The southern halves of Yarrow and Doon townships were mapped on a broad reconnaissance scale by Collins (1913). In 1916, following the discovery of gold in Powell Township, Burrows (1918) mapped northern Yarrow Township on a reconnaissance scale. Cooke (1919) mapped the northern halves of Yarrow and Doon townships, and also described in detail the property of Matachewan Consolidated Mines Limited which lies a short distance to the north of Yarrow Township.

Following renewed gold exploration activity, Dyer (1936) mapped the area around Matachewan in detail and studied local mine sites and mineral occurrences. He also mapped townships to the northeast of Matachewan and attempted to relate the local geology to that of the Kirkland Lake area.

Present Geological Survey

The objective of this project was to examine previously unmapped areas of Yarrow and Doon townships inferred to be underlain by rocks of the Huronian Supergroup. In addition, inliers of Archean metavolcanic, metasedimentary and plutonic rocks were identified. These, however, were not exhaustively studied.

Field work for this report was performed between May 23 and September 1, 1987. The crew consisted of the author, one senior assistant and three junior assistants. Map 2546 (back pocket) presents the results of this survey.

Two sets of aerial photographs (1:15 840 scale), taken in 1970 and 1978, were used in field mapping. In addition, aerial photographs taken in 1986 (1:20 000 scale) were enlarged to a scale of 1:10 000 for use in field mapping, particularly in areas where logging and road construction occurred after 1978. Field data from the aerial photographs were plotted on base maps of the appropri-

ate scale. The 1:10 000 scale base maps were later reduced to a scale of 1:15 840 and the data replotted.

Outcrops were reached and examined using pace and compass methods of traversing. The outcrop geology and boundaries of outcrop areas were plotted in the field on acetate overlays to the aerial photographs. The data were transferred to cronaflex base maps prepared by the Cartography Section of the Surveys, Mapping and Remote Sensing Branch of the Ontario Ministry of Natural Resources. The base maps, at scales of 1:15 840 and 1:10 000, were prepared from Forest Resource Inventory maps (scale 1:15 840 or 1 inch to 1/4 mile) of the Timber Branch of the Ontario Ministry of Natural Resources. Traverses were not spaced at regular intervals but rather were designed to intersect areas providing the most abundant outcrop. The geology is not tied to surveyed lines.

Acknowledgments

The author received able assistance in the field from D. Conrod, H. James, T. Konkin and M. Paoli. D. Conrod, in her capacity as senior assistant, was responsible for mapping approximately 50 percent of the area.

The help and cooperation of the staff of the Regional Office of the Ontario Ministry of Natural Resources in Swastika is gratefully acknowledged, as is the assistance given by staff of the Resident Geologist's Office, Kirkland Lake.

Special thanks are extended to Henry and Lise Batisse, proprietors of Camp Matachewan, for their hospitality and generosity.

Mineral Exploration[1]

Considerable prospecting activity, as well as production from a number of mines, has taken place in the area adjacent to Yarrow and Doon townships. To the west, in Midlothian Township, gold discoveries led to prospecting and staking rushes in 1909, 1918 and again in 1944. In 1965, the Stairs Mine began gold production but closed after several months due to insufficient ore reserves and increased mining costs (Bright 1970). During the field season of 1987, the area around the site of the Stairs Mine was being re-evaluated by Goldteck Exploration Limited. To the north, in Bannockburn Township, the Ashley Mine produced gold circa 1930. Immediately to the northeast of the map area, in Baden, Alma, Powell and Cairo townships, gold prospecting activity began in 1909 and reached a peak in the 1930s (Lovell 1967). The Young–Davidson Mine, owned by Hollinger Consolidated Gold Mines Ltd., operated from 1934 to 1956 and produced 585 690 ounces of gold and 131 989 ounces of silver. The mineralization was hosted by quartz-carbonate veins in red syenite porphyry. Matachewan Consolidated Mines Limited operated a mine from 1934 to 1954 and produced 370 427 ounces of gold and 133 710 ounces of silver. The mineralization was hosted by quartz veins in carbonatized, chrome-mica-bearing metavolcanic rocks (Lovell 1967).

In 1948, gold exploration was carried out on the Vandeventer claims, which lie approximately 2 km southwest of Mudpack Lake. Low gold values were reported from a quartz vein system cutting highly deformed "granitized greenstone".

Between 1949 and 1952, Matarrow Lead Mines Limited drilled 30 holes totalling 2612 m in length in the metavolcanic rocks and banded iron formation of northwestern Yarrow Township. This exploration led to the development of the Matarrow Mine, which operated from 1951 to 1953, producing lead from a sheared, silicified and carbonatized Archean banded iron formation. In 1957, Maralgo Mines Ltd. explored for copper in quartz-veined and brecciated rocks in southeastern Yarrow Township; 23 holes were drilled totalling 911 m in length. In 1963, the Barker Mining Syndicate drilled five holes, totalling 448 m in length, in the course of a gold exploration program in sheared and carbonatized metavolcanic rocks in northwestern Yarrow Township. In 1979, Newmont Exploration of Canada Limited performed magnetometer and very low frequency (VLF) electromagnetic surveys on a claim group held by R.B. Schaus, in north-central Yarrow Township. At the time of writing, Extender Minerals of Canada Limited was producing barite from veins which cut rocks of the Gowganda Formation on the west shore of Mistinikon Lake.

In May 1978, as a result of a legal dispute between the Province of Ontario and the Teme-Augama Anishnabai native people, a tract of land which includes the map area was closed to the staking and recording of mining claims. This action is referred to as the "Bear Island Caution". At the time of writing, the case was scheduled to be heard before the Ontario Court of Appeal.

[1] *Information current to December 31, 1987.*

General Geology

The map area lies along the northwestern margin of the Cobalt Embayment of the Southern Structural Province in the Canadian Shield (Card et al. 1972). The oldest rocks in the area are Late Archean mafic to felsic flows and tuffs of the Larder Lake Group and of the Upper Deloro Group; the latter has been dated at 2725 ± 2 Ma (MERQ–OGS 1983). The Larder Lake Group is associated with Late Archean metasedimentary rocks of the Porcupine Group (MERQ–OGS 1983) which consist of diamictite, banded chert-magnetite iron formation and lithic wacke. The metavolcanic and metasedimentary rocks strike to the northeast and dip steeply to the southeast. They have been intruded by felsic plutonic rocks of the Round Lake batholith, which range in composition from granodiorite to granite (Lafleur and Hogarth 1981). The felsic plutonic rocks range from massive to gneissic in texture and locally are highly deformed and mylonitized. All of these rocks have been intruded by diabase dikes of the Late Archean Matachewan swarm, which has been dated at 2633 ± 93[2] Ma by Rb-Sr methods (Gates and Hurley 1973).

The Late Archean rocks are unconformably overlain by sedimentary rocks of the Early Proterozoic Gowganda Formation (Cobalt Group, Huronian Supergroup), which has been dated at 2240 ± 174 Ma by Rb-Sr methods (Fairbairn et al. 1969). This is probably a minimum age of this unit. In the Cobalt Embayment, the Gowganda Formation consists of the lower, glaciogenic, Coleman Member and the conformably overlying fluvial-deltaic Firstbrook Member (Donaldson et al. 1985). Only rocks equivalent to the Coleman Member occur in the map area; these consist of a heterogeneous assemblage of diamictite (polymictic paraconglomerate), sandstone, siltstone and laminated mudstone with dropstones. Strata of the Gowganda Formation dip gently to the southeast.

Nipissing intrusive rocks, which have been dated at 2219 ± 4 Ma (Corfu and Andrews 1986), intrude both the Late Archean and Early Proterozoic rocks. In the map area, Nipissing intrusive rocks are represented by a few small outcrops of fine- to coarse-grained, locally pegmatitic diabase.

The lithologic subdivisions of the map area are detailed in Table 1.

[2] *All ages in this report utilize the decay constants recommended in Steiger and Jager (1977).*

LATE ARCHEAN

METAVOLCANIC AND METASEDIMENTARY ROCKS

Intermediate to Felsic Metavolcanic Rocks (unit 1)[3]

Three inliers within the Huronian rocks of Yarrow and Doon townships expose easterly and northeasterly striking, mafic to felsic metavolcanic rocks (unit 1).

In Doon Township, intermediate metavolcanic flows occur east of Duncan Lake. The rocks are massive, aphanitic, pale grey-green on both the fresh and weathered surfaces, and exhibit a northeast-striking, northwest-dipping foliation. In thin section, the rock consists of actinolite laths surrounded by fine-grained chlorite. Very-fine-grained quartz is present interstitially. These rocks are part of the Upper Varied division of the Deloro Group (MERQ–OGS 1983).

West of Duncan Creek, pillowed, amygdaloidal and brecciated flows strike to the northeast and dip to the northwest. The rocks weather light greenish grey to brown. On a fresh surface these rocks are medium to dark greenish grey. The pillows are approximately 60 cm long and 25 cm wide. Pillow selvages are 1 to 3 cm in width. Amygdules are 0.25 to 0.50 cm in diameter, are filled with carbonate and occur throughout the pillows. In thin section, the amygdaloidal rock consists of thin laths and needles of altered plagioclase set in a groundmass of devitrified glass. The pillowed horizon grades to a flow-top breccia displaying light grey-weathering angular fragments, 0.5 to 15 cm in diameter, set in a brown-weathering, fine-grained matrix (Photo 2). Pillow shapes and the gradation to flow-top breccia indicate that the succession is north facing. These rocks are part of the Larder Lake Group (MERQ–OGS 1983).

Intermediate to felsic metavolcanic flows and tuffs are exposed by an inlier to the east of Mistinikon Lake, in north-central Yarrow Township. The zone of metavolcanic rocks is 1.5 km in width and is truncated to the south by felsic intrusive rocks and is covered to the east and north by rocks of the Gowganda Formation. The metavolcanic rocks are part of the Larder Lake Group (MERQ–OGS 1983). They are reddish brown on both weathered and fresh surfaces, are typically massive and aphanitic, and exhibit a northeast-striking, southeast-dipping foliation. In thin section, the rock consists

[3] *Unit numbers refer to those on Map 2546 (back pocket).*

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR YARROW AND DOON TOWNSHIPS.

PHANEROZOIC

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT

Glacial, glaciofluvial, swamp, lake and stream deposits

UNCONFORMITY

PRECAMBRIAN

EARLY PROTEROZOIC

Mafic Intrusive Rocks

Nipissing Intrusive Rocks

Fine- to coarse-grained diabase; locally pegmatitic

INTRUSIVE CONTACT

Huronian Supergroup

Cobalt Group

Gowganda Formation

Diamictite, lithic arkose to feldspathic litharenite, lithic arkosic wacke to feldspathic lithwacke, siltstone, laminated mudstone-siltstone, laminated mudstone-siltstone with dropstones

UNCONFORMITY

LATE ARCHEAN

Mafic Intrusive Rocks

Diabase (Matachewan diabase)

INTRUSIVE CONTACT

Intermediate Intrusive Rocks

Diorite

INTRUSIVE CONTACT

Felsic Intrusive Rocks

Granitic Rocks and Gneisses

Gneissic granodiorite, xenolith-bearing gneissic granodiorite, cataclastic gneissic granodiorite and mylonite, foliated leucocratic granite, massive to foliated hornblende-rich granodiorite, aplite, pegmatite

INTRUSIVE CONTACT

Metavolcanic and Metasedimentary Rocks

Metasedimentary Rocks

Diamictite, banded magnetite-chert iron formation, lithic wacke

Intermediate to Felsic Metavolcanic Rocks

Pillowed, vesicular, and amygdaloidal flows, massive flows, tuff

of highly sericitized plagioclase phenocrysts in a groundmass of very-fine-grained recrystallized quartz. Alteration products consist of abundant granular masses of epidote, fibrous blades of actinolite and minor amounts of chlorite. Tuffs are poorly exposed and display dark greenish-grey and brownish-grey bands approximately 1 cm in thickness.

Carbonatized and silicified metavolcanic rocks are present in a strongly foliated zone about 600 m in width, which lies adjacent to the main access road a short distance south of the northern boundary of Yarrow Township.

Metasedimentary Rocks (unit 2)

Metasedimentary rocks (unit 2) are exposed west and northwest of Elmer Lake in Doon Township. Exposure of these rocks is obscured by a mantle of sand and gravel. The succession consists of diamictite, laminated to cross-stratified sandstone, along with minor amounts of siltstone. The clast composition of the diamictites is dominated by felsic to intermediate metavolcanic rock

Photo 2. Flow-top breccia in metavolcanic rocks, Doon Township. Stratigraphic top is toward the upper left of the photo.

types. Less abundant are clasts of mudstone, chert, banded iron formation and mafic to ultramafic metavolcanic rocks. The clasts are mainly subangular to rounded and range from 1 to 30 cm in diameter (average 3 cm). The matrix of the diamictite is fine- to medium-grained sandstone in which ferroan carbonate replacement alteration is common. The poor sorting and matrix-supported texture of the diamictites suggests deposition by debris flows. Cross-stratification and graded bedding in overlying strata are exposed in Midlothian Township and indicate that the succession faces northward.

The metasedimentary rocks exposed in Doon Township are correlative with a succession in Midlothian Township which is approximately 3 km thick and consists of both massive and stratified diamictite, cross-stratified, clast-supported pebble conglomerate, cross-stratified sandstone and graded and laminated siltstone. The contact with underlying metavolcanic rocks was not observed in the map area; however, in Midlothian Township, a roadside outcrop displays a sheared contact between tuffs and diamictite. The lower part of the metasedimentary succession may represent a rapid transition from an environment of subaqueous resedimentation to one dominated by fluvial processes. This was followed by a return to a subaqueous environment and the deposition of thin turbidites interbedded with tuffs. Hyde (1980) has suggested that these rocks represent the Timiskaming Group, whereas others consider them part of the Larder Lake Group (MERQ–OGS 1983).

Banded chert-magnetite iron formation is interbedded with metavolcanic rocks on the east shore of Mistinikon Lake, in northeastern Yarrow Township. The unit is approximately 60 m in width and is exposed along strike for about 1 km. The unit trends northeast. Foliation strikes to the northeast and dips steeply to the southeast. The rock consists of tightly folded, finely banded, alternating layers of silica and magnetite (Photo 3).

FELSIC INTRUSIVE ROCKS

Granitic Rocks and Gneisses (unit 3)

Granitic rocks and gneisses (unit 3) are exposed in the western half of Yarrow Township and form the northwestern margin of the Round Lake batholith, which is a composite body consisting of gneissic granodiorite, plus tonalite, granite, quartz monzonite, diorite and syenite. The granitic rocks occur mainly as stocks and display both concordant and discordant intrusive relationships with the gneissic granodiorite (Lafleur and Hogarth 1981).

In the map area, rocks of the Round Lake batholith are composed mainly of medium-grained gneissic granodiorite to tonalite, which displays faint banding defined by differences in grain size and composition. The rock is light grey to pinkish grey on the weathered surface and dark pinkish grey on the fresh surface. A weak to moderate foliation is expressed by elongated masses of quartz and feldspar. In thin section, the rock consists of large, strongly sericitized plagioclase laths surrounded by sutured quartz grains and orthoclase. Hornblende has been largely replaced by epidote and chlorite, whereas biotite has been altered to chlorite (Photo 4).

In central Yarrow Township, an 800 m wide, east-trending zone of highly deformed, xenolith-bearing

Photo 3. Banded chert-magnetite iron formation exposed on the eastern shore of Mistinikon Lake.

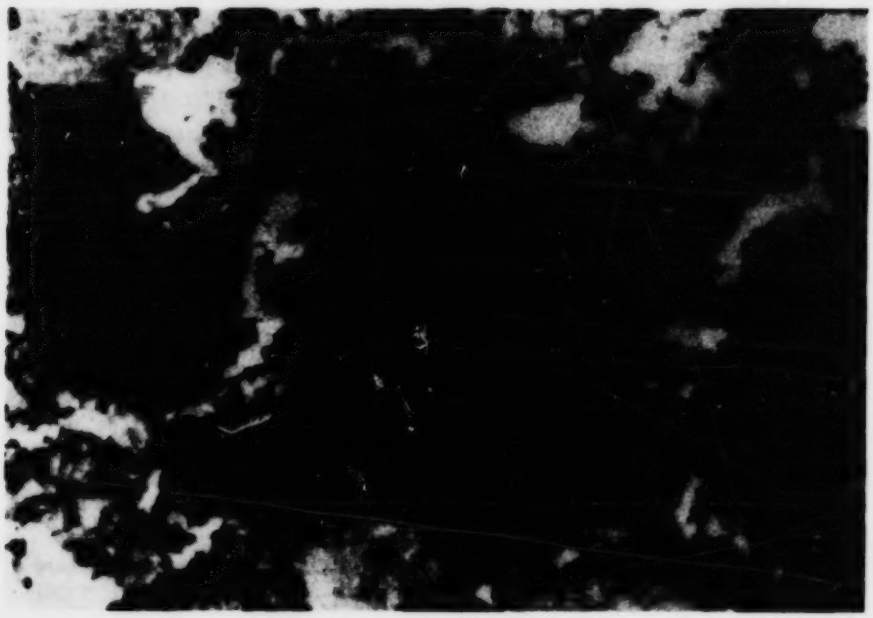

Photo 4. Photomicrograph of gneissic granodiorite. Note the large sericitized grains of plagioclase and the sutured texture of the quartz grains. The dark fibrous material in the centre of the photo is chlorite, altering from biotite. Field of view 4 mm. Crossed nicols.

gneissic granodiorite was observed. The xenoliths are dark greenish grey, fine grained and finely laminated. At some localities, the xenoliths appear to have been transposed into parallelism with the gneissic rocks (Photo 5). This zone contains deformed porphyroblasts which indicate left-lateral shearing. In thin section, the rock consists of hornblende with a strong preferred orientation along with interstitial quartz. The hornblende has been partly altered to granular aggregates of epidote.

In southwestern Yarrow Township, the xenolith-bearing gneiss has been mylonitized. The rock weathers

Photo 5. Highly deformed gneissic granodiorite and mafic material exposed along the road which runs parallel to the logging road in Yarrow Township.

reddish brown and contains pink feldspar porphyroblasts, along with blebs and rootless folds of pink gneissic rock (Photo 6). In thin section, the porphyroblasts are strongly sericitized plagioclase which are surrounded by fibrous chlorite, quartz and epidote. The chlorite is an alteration product of hornblende and displays a strong preferred orientation.

Foliated to massive leucocratic granite occurs in southeastern Yarrow Township on the eastern shore of Sisseney Lake, and in western Yarrow Township on the eastern shore of Mistinikon Lake. The rock weathers light pink and contains quartz phenocrysts up to 1 cm in diameter. On the fresh surface it is reddish grey. In thin section, the rock consists of plagioclase, microcline, microperthite and biotite. At one locality, this rock type intrudes the mylonite described above and hence postdates the deformational event (Photo 7).

Hornblende-rich granodiorite occurs at a number of localities, but is most abundant in southwestern Yarrow Township, where it appears to form a stock and displays discordant relationships with the gneissic granodiorite. The rock is light grey to light pink on both the fresh and weathered surfaces. Hornblende crystals range up to 1 cm in length and locally define a mineral lineation. In thin section, the rock consists of large, strongly sericitized plagioclase laths and potassium feldspar with interstitial polycrystalline quartz. Large hornblende crystals are strongly altered to epidote and chlorite. Biotite, titanite and zircon are minor constituents (Photo 8).

Light grey quartzofeldspathic veins, 1 to 10 cm in width, are abundant in the gneissic granodiorite and are crosscut by thin pegmatite veins. Both types of veins are not present in the xenolithic gneiss and mylonitic zones and are rare in the leucocratic granite and hornblende-rich granodiorite.

Lafleur and Hogarth (1981) suggest that the Round Lake batholith was emplaced in a mafic volcanic sequence as a magmatic diapir. The intrusion cooled and partly solidified as it moved upward in the dense mafic volcanic sequence. This would account for the foliated and cataclastic nature of the early granodiorite and the massive nature of the later granites. Jensen and Langford (1985) envisage the generation of batholiths in the Abitibi Greenstone Belt as a process involving downward faulting, buckling and tilting of calc-alkalic volcanic rocks which then underwent partial melting to produce diapirs of felsic magma.

INTERMEDIATE INTRUSIVE ROCKS

Diorite (unit 4)

Diorite (unit 4) is exposed at two localities along the shore of Mistinikon Lake: a small outcrop on the south side of the bridge which crosses Mistinikon Lake, and on a point 1 km south of the bridge. The distribution of outcrops suggests that the rock unit is a dike, although contacts with the surrounding rocks were not observed. The rock weathers dark brown to tan. On a fresh surface, green plagioclase phenocrysts up to 3 cm long are visible and have an east to northeasterly long-axis orientation. The phenocrysts are set in a pink to dark brown groundmass. In thin section, the rock displays an ophitic texture defined by plagioclase, pyroxene and rare potassium

Photo 6. Porphyroclastic mylonite in a roadside exposure in southwestern Yarrow Township. Note the rootless folds and the crosscutting offshoot of a Matachewan diabase dike.

feldspar; chlorite, epidote and carbonate are alteration products.

MAFIC INTRUSIVE ROCKS

Matachewan Diabase (unit 5)

Matachewan diabase dikes (unit 5) are abundant in the map area. The dikes are typically 5 to 10 m in width and trend slightly west of north. They are best exposed in Yarrow Township, where they intrude the felsic rocks of the Round Lake batholith. Good exposures are also found in a cleared area in west-central Doon Township, where the dikes intrude metavolcanic rocks. The diabase is light brown to reddish brown on weathered surfaces. It contains white-weathering plagioclase laths up to 4 cm in length which commonly show a preferred orientation. Plagioclase glomerocrysts are up to 3 cm in diameter. The rock is dark green on the fresh surface. In coarser grained dikes, ophitic texture is visible on both fresh and weathered surfaces. The dikes are massive, fine to coarse grained, and magnetic. In thin section, the rock displays a subophitic texture defined by sericitized plagioclase and augite, with interstitial quartz, chlorite, and opaque grains of magnetite.

EARLY PROTEROZOIC

HURONIAN SUPERGROUP

Cobalt Group

GOWGANDA FORMATION

In the Cobalt area, the Gowganda Formation consists of two members. The glaciogenic Coleman Member un-

Photo 7. Hornblende-rich granodiorite intruding porphyroclastic mylonite. Roadside exposure, southwestern Yarrow Township.

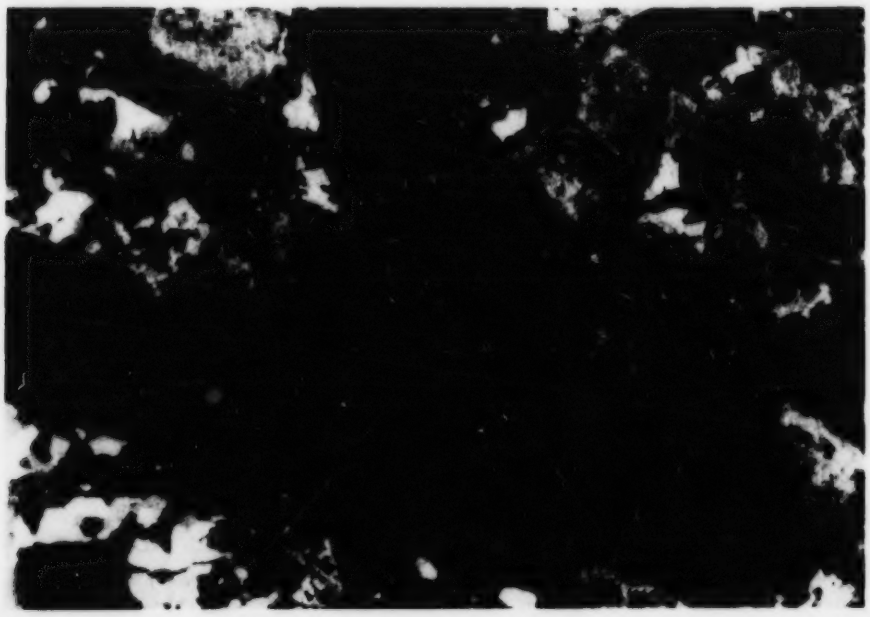

Photo 8. Photomicrograph of hornblende-rich granodiorite. Minerals present include microcline, quartz and plagioclase. The dark mineral at the top centre is hornblende altered to a granular mass of epidote. Field of view 4 mm. Crossed nicols.

conformably overlies the Late Archean basement and ranges in thickness from 200 to >500 m (Mustard and Donaldson 1987). Evidence for the glacial origin of the Coleman Member includes the presence of extensive diamictites and dropstones. The Coleman Member is gradationally overlain by the fluvial-deltaic Firstbrook Member, which reaches a maximum thickness of approximately 530 m (Rainbird 1986).

Lower Gowganda Formation (Coleman Member) (unit 6)

In the map area, the Lower Gowganda Formation rests unconformably on the Archean basement and contains diamictites and dropstone-bearing siltstones, and is here considered equivalent to the Coleman Member of the Cobalt area. The only Huronian rocks in the map area are those of the Coleman Member, which attain a maximum thickness of 200 m. The succession locally forms a coarsening-upward cycle beginning with approximately 45 m of siltstone, laminated mudstone-siltstone, laminated mudstone and siltstone with dropstones, and minor amounts of diamictite (polymictic paraconglomerate) and sandstone. The remainder of the succession consists of approximately 155 m of interbedded diamictite and sandstone and minor beds of siltstone (Figure 2).

Rock Descriptions

Siltstone (unit 6d) is apparently massive and is dark greenish grey on both fresh and weathered surfaces. Angular, pink, feldspathic rock fragments, 1 to 2 mm in diameter, are commonly visible in hand specimen as are lenses of pink to dark red weathering, fine-grained sand-

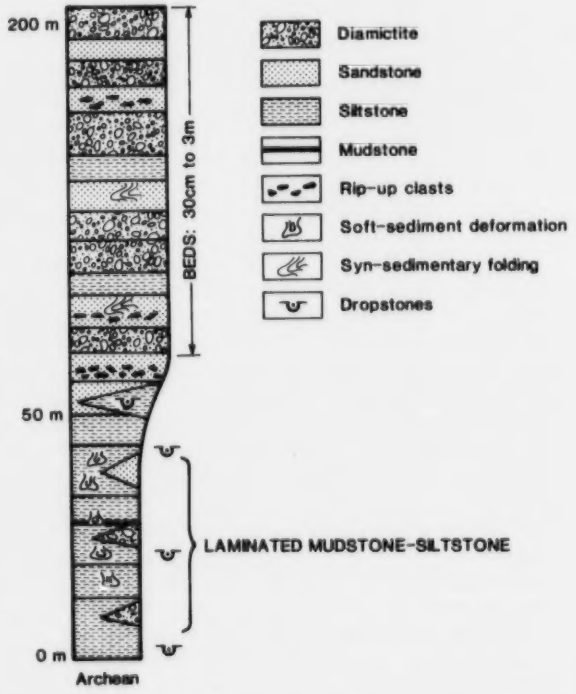

Figure 2. Generalized diagram of the stratigraphy of the Gowganda Formation in Yarrow and Doon townships.

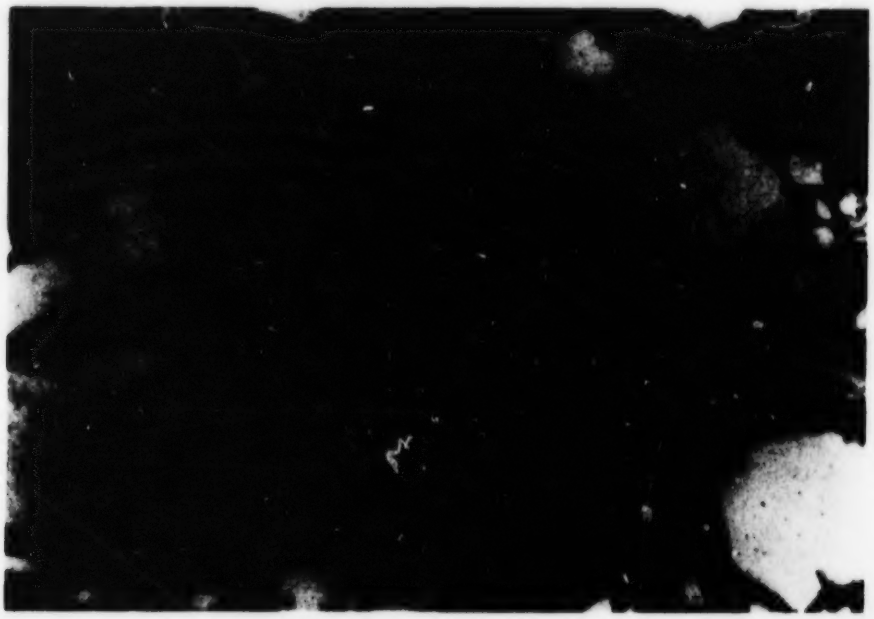

Photo 9. Photomicrograph of wacke clast (till pellet) in interlaminated siltstone and mudstone of the Gowganda Formation. Note the rounded form and the closely packed angular to subrounded grains. Field of view 4 mm. Plane polarized light.

stone which are approximately 1 cm thick and 5 cm long. In thin section, the rock consists of angular to subrounded silt-sized grains in a matrix of chlorite and sericite, which represent the original clay constituents. The silt-sized grains consist of quartz, plagioclase, potassium feldspar and rock fragments (mudstone, metamorphic quartz-feldspar aggregates and wacke clasts or "till pellets"; *see* Photo 9). Faint stratification is defined by discontinuous single grain layers, subtle changes in grain size and normal grading.

Interlaminated mudstone and siltstone present a banded appearance on the weathered outcrop surface (Photo 10). Siltstone laminae weather to medium brownish grey whereas mudstone laminae weather light grey. On the fresh surface, both rock types are dark greenish grey. Laminae range in thickness from 0.5 to 2 mm. The siltstone laminae commonly display pink-weathering, feldspathic rock fragments 1 to 2 mm in diameter. Also present are rare dropstones up to 3 mm in diameter. Mudstone laminae are gently undulatory and conform to irregularities in underlying graded siltstone laminae. This unit is also distinguished by discontinuous bodies, centimetres to decimetres in diameter, of pink fine-grained sandstone. These are circular to irregular in shape, thin (< 5 cm), commonly display contorted laminae and are probably the result of soft-sediment deformation and lateral slumping (Photo 11). In thin section, interlaminated mudstone-siltstone consists of rhythmic alternations of coarse- and fine-grained laminae. The fine-grained laminae are composed of chlorite and sericite and show very fine stratification and single-grain layers of silt-sized material. The coarser grained laminae are made up of angular to subrounded,

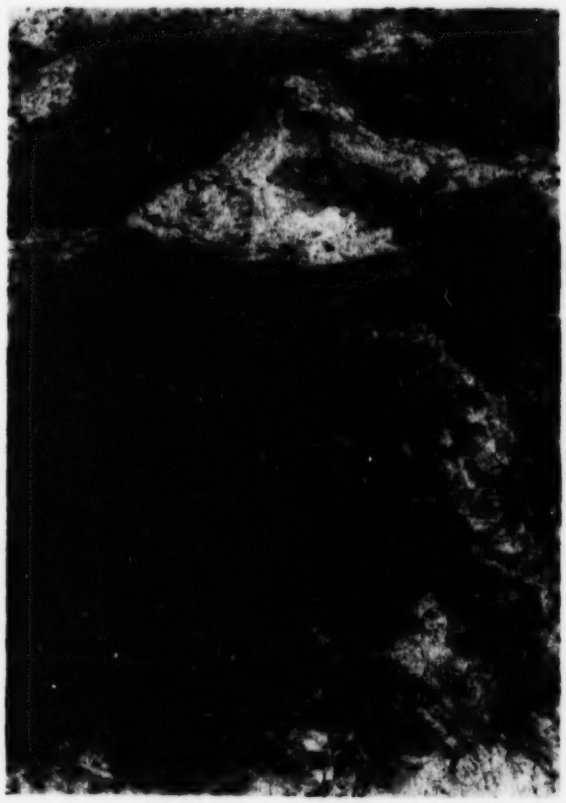

Photo 10. *Laminated siltstone and mudstone from the Gowganda Formation. Dark grey laminae are siltstone; light grey laminae are mudstone.*

Photo 11. *Ball-and-pillow structures from the Gowganda Formation. Note the sandstone balls which contain original laminae now deformed by slumping.*

Photo 12. *Photomicrograph of dropstone in laminated siltstone and mudstone from the Gowganda Formation. Note the deformed laminae below the clast and the small angular clasts of quartz and feldspar.*

silt-sized grains of quartz, feldspar, and rock fragments in proportions similar to those found in the massive siltstone described above. The coarse-grained laminae are normally graded and show evidence of having scoured the underlying sediment.

Interlaminated mudstone-siltstone containing numerous dropstones (unit 6e) is interbedded with unit 6d. The dropstones range from 1 to 15 cm in diameter. The larger clasts strongly deform underlying sediment and have been draped by overlying laminae (Photos 12 and

Photo 13. *Granitic dropstone in laminated siltstone and mudstone from the Gowganda Formation. Note the deformed laminae below the clast and the draping of laminae over the clast.*

13). Clast types are similar to those found in the diamictites and consist of pink, quartz-phyric granite, granodiorite, mafic to felsic metavolcanic rocks, diabase and vein quartz. Also present are normally graded laminae of siltstone and fine-grained sandstone.

Diamictite (unit 6a) constitutes approximately 40 percent of the Gowganda Formation in the map area. A diamictite is defined as a poorly sorted, noncalcareous, terrigenous sedimentary rock that contains a wide range of particle sizes, typically clasts of pebble to boulder size, supported by a muddy matrix (Bates and Jackson 1987).

Massive diamictites are light to dark greenish grey on the weathered surface and dark greenish grey on the fresh surface. Clasts range from 0.5 to 90 cm in diameter (average 3 cm) and make up 2 to 20 percent of the rock. The clasts are supported by a siltstone matrix. The clasts are typically subangular to subrounded and are dominated by pink, quartz-phyric granite (45 percent) and granodiorite (35 percent). The remainder of the clast types are mafic to felsic metavolcanic rocks (12 percent), vein quartz (3 percent), diabase (3 percent), metasedimentary rocks (1 percent) and schist (1 percent). Massive diamictites are thickly to very thickly bedded and typically display sharp contacts with other units. Loading of underlying beds occurs at the bases of some units. Lenses of diamictite, approximately 1 m thick and 4 m long, were observed within sandstone beds (Photo 14). Clasts within these lenses are more closely packed than in massive diamictite beds. Inverse grading of clasts and soft-sediment deformation were also observed in the lenses. In thin section, the diamictite matrix consists of angular to subrounded, silt-sized grains of quartz,

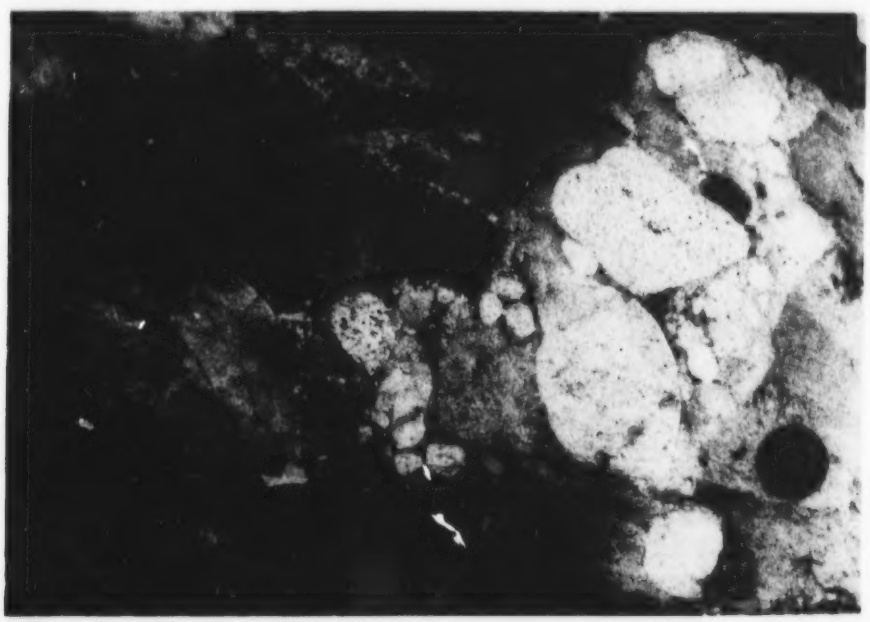

Photo 14. *Lens of diamictite in sandstone from the Gowganda Formation. Note the close packing of clasts and the small pebble-filled injection structure above the centre of the photo.*

feldspar and rock fragments set in a matrix of chlorite and sericite. Rounded detrital grains of apatite and zircon are also present. Small amounts of carbonate and hematite are present as cement.

Stratified diamictites are less abundant in the local succession than are massive diamictites. They were observed in good exposures near the property of Extender Minerals of Canada Limited on the west shore of Mistinikon Lake. The stratified diamictites display very thin beds defined by matrix grain size differences and feldspar content. The matrix of the stratified diamictites is slightly coarser grained than that of massive diamictites, and ranges from siltstone to fine-grained sandstone. The clast composition is similar to the massive diamictites, but the average clast size (2 cm) is smaller. Units of stratified diamictite are 1 to 2 m thick and have gradational contacts with massive diamictite and sandstone.

In a detailed study of the area around the Extender Minerals of Canada Limited property, Knightly (1987) observed the following: 1) clast a-axis orientation to the east-southeast and to the south-southwest; 2) small recumbent flow folds indicating slumping toward the southeast; 3) evidence for soft-sediment deformation including ball-and-pillow structures and flame structures; 4) rare trough cross-bedding indicating the presence of northwesterly directed traction currents; and 5) dropstones which deform underlying sandstone wisps.

The arenites (lithic arkose to feldspathic litharenite; unit 6c) are fine to coarse grained and medium to thickly bedded. The lower contacts of beds are typically sharp. Arenites range in composition from lithic arkose to feldspathic litharenite (classification of Dott 1964; Figure 3). Both are pink to red on weathered and fresh surfaces and are typically massive in appearance. Rare parallel lamination, cross-lamination, thin bedding and shallow scour surfaces are present and are defined by differences in grain size and feldspar content. Some beds of coarse-grained arenite contain rip-up clasts of mudstone which have been deformed during resedimentation. Decimetre-scale synsedimentary folds are exposed in roadside outcrops to the west of Mistinikon Lake. In thin section, lithic arkose is observed to be poorly sorted, consisting of angular to subrounded detrital grains of quartz (45 percent), feldspar (plagioclase > potassium feldspar; 35 percent) and rock fragments (metamorphic, plutonic, diabase; 20 percent). Apatite and zircon are minor (< 1 percent) constituents. Interstitial sericite, hematite and carbonate constitute less than 5 percent of the rock (Photo 15). Feldspathic litharenite is less abundant than lithic arkose and is distinguished by a greater percentage of rock fragments (30 to 35 percent; Figure 3).

Wacke (lithic arkosic wacke to feldspathic lithwacke; unit 6b) is dark grey on both fresh and weathered surfaces and is typically massive. The composition ranges from lithic arkosic wacke to minor feldspathic lithwacke (classification of Dott 1964; Figure 3). In thin section, lithic arkosic wacke is observed to be very poorly sorted, consisting of detrital grains (quartz, feldspar, rock fragments) which occur in similar proportions to those in the arenites. The matrix constitutes approximately 15 percent of the rock and consists of angular to subrounded, silt-sized detrital grains set in chlorite and sericite. Feldspathic lithwacke is less abundant than lithic arkosic wacke and is distinguished by a greater percentage (30 to 40 percent) of rock fragments.

Siltstone is rare in the upper part of the succession. It is commonly parallel laminated to wavy bedded; cross-lamination is rare. Bedding thickness of the wackes ranges from 10 cm to 1 m, with an average of 20 cm.

Basal strata of the Coleman Member are exposed along roadsides and in cleared areas to the northwest of Elmer Lake, in Doon Township, where beds of the Coleman Member lie at the same topographic level as Archean metavolcanic rocks less than 0.5 km distant; the unconformity surface was not observed. The basal strata consist of massive siltstone and laminated mudstone-siltstone, with rare interbeds and lenses of diamictite, arenite and wacke.

Basal strata of the Coleman Member were also observed in central Yarrow Township, where they lie in close proximity to felsic plutonic rocks of the Round Lake batholith. The unconformity surface was not observed. In the central and south-central parts of the township, the basal strata consist of interbedded diamictite and wacke. In the north-central part of the township, the basal strata consist of massive siltstone and laminated mudstone-siltstone with dropstones.

The upper part of the succession, which is dominated by diamictite and sandstone, is exposed in Doon Township by hills which lie to the east and west of Elmer Lake and to the southeast of Mistinikon Lake. Good exposures are also found to the east and west of the unnamed lake in north-central Doon Township. In Yarrow Township, the upper part of the succession is exposed by hills lying to the west of Sisseney Lake and to the southwest of Matachewan. Good exposures of diamictites and sandstones are seen in the roadcut adjacent to the property of Extender Minerals of Canada Limited.

Depositional Environment

Introduction The Gowganda Formation has long been considered to be of glacial origin. Coleman (1908) interpreted the unstratified diamictites of the lower part of the Gowganda Formation in the Cobalt area to be the deposits of continental glaciation. Lindsey (1969) proposed a terrestrial to lacustrine depositional environment for the Coleman Member of the Cobalt area, and a glaciomarine setting for the lower Gowganda Formation in the Sudbury–Espanola area. Miall (1983) has suggested a glaciomarine origin for rocks in the northern Cobalt Embayment which are stratigraphically equivalent to the Coleman Member. Mustard and Donaldson (1987) interpret the Coleman Member in the Cobalt area as the deposits of a locally grounded ice sheet followed by subaqueous outwash deposition in front of a slowly retreating tidewater glacier. This was followed by sedimentation from a partly floating ice sheet.

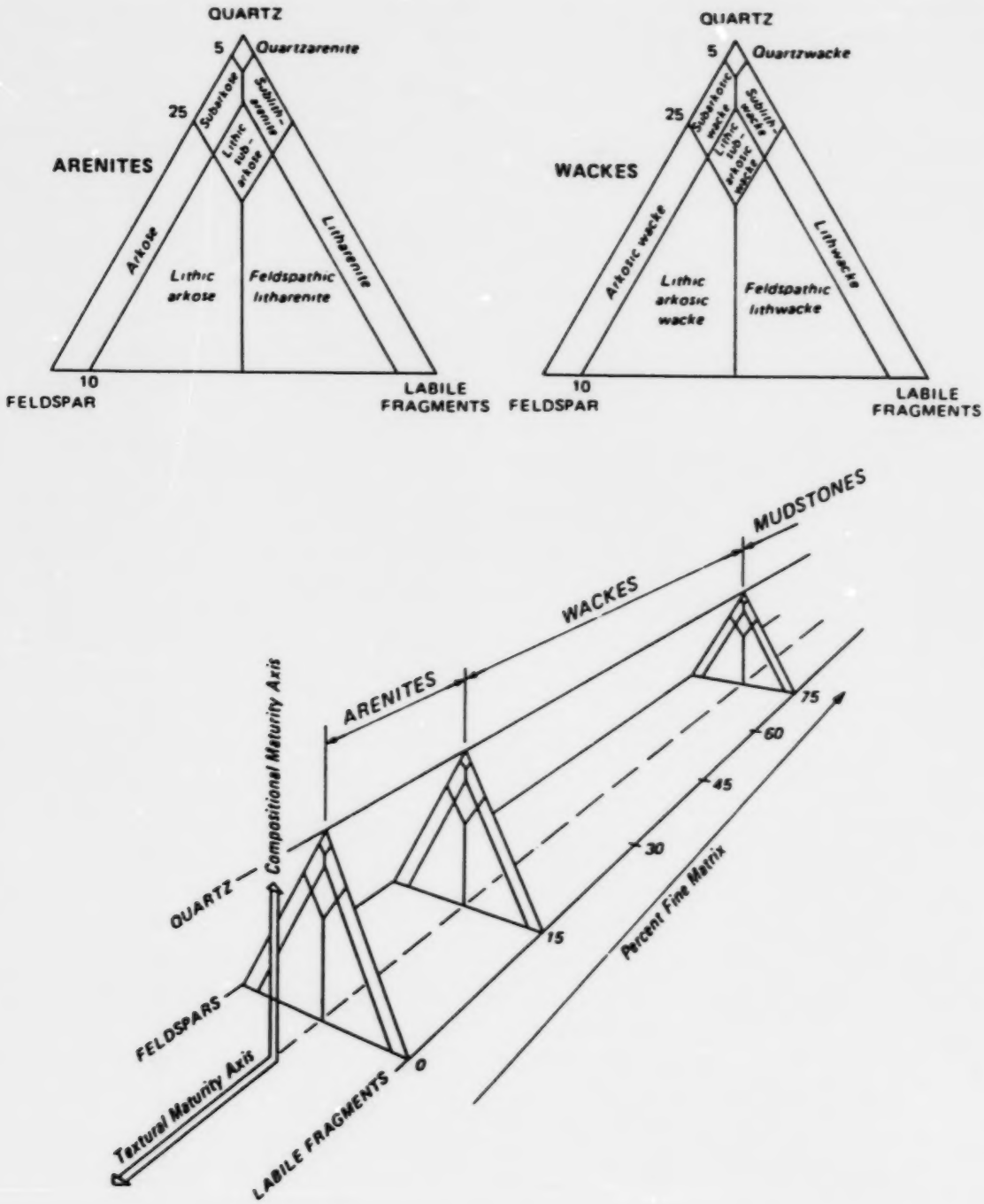

Figure 3. Sandstone classification diagram (modified from Dott 1964).

The rock units discussed below are interpreted in the context of a model of glaciomarine sedimentation involving a major ice sheet fed by continental glaciers (Drewry 1979; Thomas 1979; Miall 1983) (Figure 4). The ice sheet was situated over a continental margin and may have been grounded on the marine shelf or on topographic highs such as areas of elevated bedrock lying deeper within the basin (*see* Miall 1983, Figure 6).

Photo 15. Photomicrograph of lithic arkose from the Gowganda Formation. Minerals present include quartz and plagioclase, with lithic fragments and minor amounts of matrix.

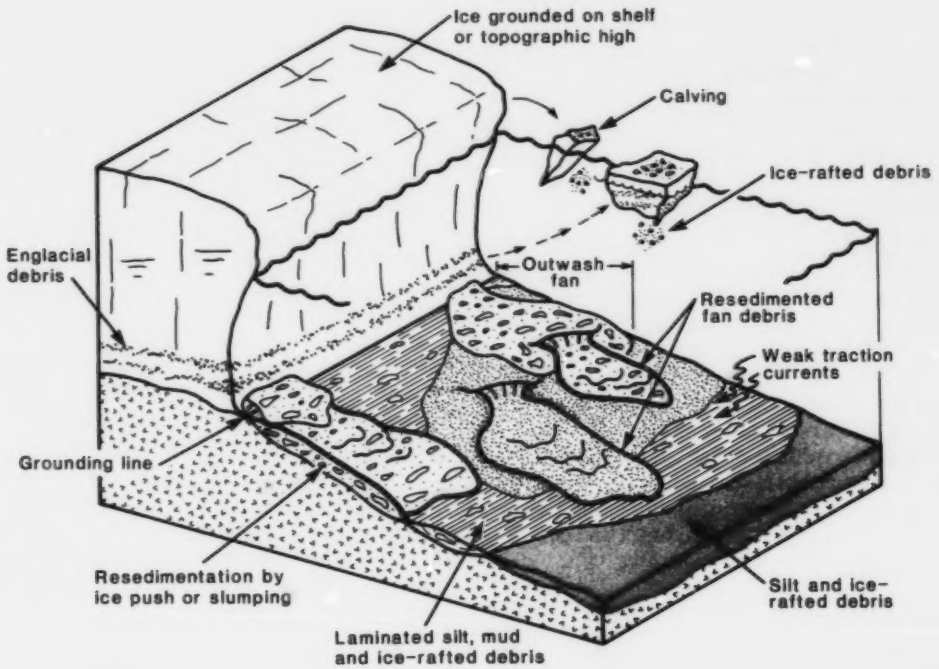

Figure 4. Model for glaciomarine sedimentation depicting an ice sheet grounded on the continental shelf or on a topographic high within the basin. A floating ice shelf can be present at the foot of the glacier. The scale of this environment can range up to several tens of kilometres (after Mustard and Donaldson 1987).

Interpretations Siltstones which display faint stratification and normal grading were deposited from suspension and by turbidity currents in the distal part of the zone of gravity flows in a hemipelagic environment (Miall 1983). Wacke clasts ("till pellets") are frozen aggregates of glacial debris which were deposited by melt-out from shelf ice or icebergs. Small sandstone lenses ("starved ripples") indicate the presence of weak traction currents which reworked the minor amounts of sand deposited from melt-out or by turbidity flows.

Laminated mudstone-siltstone couplets displaying normal grading and evidence of scouring are the products of turbidity flows. The regularity of the mudstone-siltstone layers and the presence of scour surfaces indicate deposition in a more proximal part of the gravity flow zone. Dropstones attest to the continued presence of floating ice. Ball-and-pillow structures and deformed sandstone bodies may have originated as "starved ripples" formed by traction currents; these ripples later foundered as a result of density-induced loading (Miall 1983).

Massive diamictites, consisting of poorly sorted material and displaying a preferred long-axis orientation of clasts, are the products of debris flows which originated near the ice shelf grounding line. At such locations (continental shelf, topographic highs) ice push, oversteepening, or isostatic adjustment of the basin related to ice advance and retreat can trigger resedimentation of glacial debris. A modern analog for this depositional environment has been described from Antarctica by Kurtz and Anderson (1979). Lenses of massive diamictite within stratified diamictite and sandstone are the result of iceberg overturn. This process occurs when newly calved icebergs undergo melting, become unstable and capsize, depositing englacial debris which has accumulated on iceberg surfaces (Ovenshine 1970).

Stratified diamictites result from a combination of normal marine sedimentation and deposition from floating ice. Dropstones and diamictite lenses are the result of ice-rafting. Trough cross-stratified sandstones and small sandstone wisps and lenses were created by normal marine currents, which reworked glacial debris. Similar deposits have been reported from the Antarctic continental shelf (Kurtz and Anderson 1979). Gradational contacts of stratified diamictites with other units in the map area were observed; such relationships have been observed in the sediments of the Antarctic continental shelf and reflect the gradual onset and decline of ice-rafting episodes.

Massive to parallel-laminated sandstones with scour structures, penecontemporaneous deformation structures and rip-up clasts are attributed to deposition from gravity flows originating on the flanks of subaqueous outwash lobes. Where grounded ice is retreating, considerable amounts of subglacial meltwater carry debris to the ice-front, where lobes of sand and silt are formed (Rust 1977). Being water-saturated and unstable, these sediments are easily liquefied and tend to form gravity flows which can move downslope for considerable distances. Normal marine sedimentation resumed between gravity-flow events and is recorded by rare, thin interbeds of ripple cross-laminated sandstone and wavy bedded siltstone deposited by weak traction currents.

Rapid lateral changes in glaciomarine facies are emphasized by the variation in basal strata in the map area. In Doon Township, basal strata consist mainly of the fine-grained deposits of turbidity flows and ice-rafted debris; discontinuous units of diamictite and sandstone may represent isolated or distal debris flows. In contrast, the basal strata of Yarrow Township consist mainly of diamictites and sandstones deposited by coarse-grained debris flows. The remainder of the succession in both areas is dominated by debris flow deposits. The lateral variability of rock types and the absence of any marker horizons prevented correlation among various exposures in the map area.

Studies of the Lower Gowganda Formation (Coleman Member) Adjacent to the Map Area The glacial origin of the lower Gowganda Formation has been studied in some detail at locations near the map area. Miall (1983) has described a 400 m thick succession observed in drill core from Fallon Township, which lies 40 km north of the map area. The succession consists of interbedded fine-grained sedimentary rocks containing dropstones, along with sandstones and diamictites. Deposition was related to a major ice shelf and was dominated by resedimentation of glacial debris via gravity flows on subaqueous outwash fans, by debris flows generated near the line of ice grounding, and by ice-rafting.

A succession ranging up to 1600 m in thickness has been described from the Gowganda–Elk Lake area, which lies 20 km to the south of the map area (Mackean 1968; Rosen 1985). The succession, consisting mainly of diamictite, sandstone and siltstone, is interpreted as the record of a major ice shelf, where debris flows and ice-rafting were the dominant depositional processes (Rosen 1985). The basal unconformity and immediately overlying strata display evidence for a variety of depositional environments. Subaerial exposure is indicated by the presence of a regolith, striated basement rock and fluvial deposits. Elsewhere, the basement has been eroded to a smooth surface and is overlain by dropstone-bearing siltstone.

In the Cobalt area, basal rocks of the Coleman Member include a regolith, breccia and massive diamictite which are interpreted as the subglacial deposits of a grounded ice sheet (Mustard and Donaldson 1987). The remainder of the succession, consisting of sandstones, diamictites and siltstones, was deposited as subaqueous outwash fans by resedimentation of glacial debris and by ice rafting.

MAFIC INTRUSIVE ROCKS

Nipissing Intrusive Rocks (unit 7)

Nipissing intrusive rocks (unit 7) are exposed in the map area by a number of isolated outcrops. In Doon Town-

ship, the larger of these outcrops are found to the east of Duncan Creek, northwest of Elmer Lake, and on the western shore of Elmer Lake. In Yarrow Township, sizeable outcrops are located to the east of the main gravel road and along the eastern shore of an unnamed lake in the southeastern part of the township. The largest outcrops in both townships are possibly erosional remnants of a once larger body, and occur near the Late Archean–Early Proterozoic unconformity along which the rocks were probably intruded.

Nipissing intrusive rocks in the map area are typically fine- to coarse-grained diabase. These rocks weather reddish brown and display a crude ophitic texture on the weathered surface. The rocks are greenish black and massive on the fresh surface. "Varied texture" is typical of the Nipissing rocks and is seen in the outcrop which lies to the east of Duncan Creek. The texture consists of irregular pods of pegmatitic gabbro within fine- to medium-grained diabase. In thin section, the rock displays a coarse ophitic to subophitic texture of saussuritized plagioclase along with uralitized augite. Quartz and graphic quartz-feldspar intergrowths are present interstitially. The opaque minerals consist of magnetite and ilmenite.

CENOZOIC

Quaternary

PLEISTOCENE AND RECENT

Pleistocene and Recent deposits cover 70 to 80 percent of the map area. Ice movement during Pleistocene glaciation was toward the southeast, as indicated by striations on bedrock surfaces. A ground moraine consisting of gravel and sand forms the ground cover over most of the map area. The western part of Doon Township is mantled by the sand deposits of a glaciofluvial outwash plain. A south-trending esker lies to the east of Kame Lake. Two parabolic sand dunes were observed north of Duncan Lake. Their curvature indicates that the prevailing wind direction in postglacial time was toward the southeast. For further details regarding the Quaternary deposits of the map area. the reader is referred to Roed and Hallett (1979). Isolated swamps are found along the flood plain of Duncan Creek and around the shores of Kame Lake. The area is otherwise dry and well drained.

Structural Geology

FOLDS

The reconnaissance nature of this study did not permit a thorough examination of the structural geology of Yarrow and Doon townships. In addition, the Archean metavolcanic and metasedimentary rocks are poorly exposed. In both townships, these rocks display a northeasterly trending foliation which dips steeply to the southeast. Foliation in the rocks exposed by the inlier in southern Doon Township strike to the northeast and dip to the northwest. In the metasedimentary rocks, the foliation is generally parallel to bedding planes. Parasitic "Z" folds in the banded iron formation in Yarrow Township plunge 70° to the northeast.

The gneissic felsic rocks of the Round Lake batholith in Yarrow Township display a northeast-trending gneissosity which is vertical or dips steeply to the northwest. Within the gneiss are discrete areas of intensely deformed to mylonitic rocks which may represent xenoliths of pre-existing metavolcanic or intrusive rocks. These deformed rocks display a northeast-trending foliation which dips steeply to the northwest. The horizontal component of shearing is left-lateral. It is emphasized that these zones were not traced out in detail.

FAULTS

Two major northeast-trending faults occur in Yarrow Township and are expressed by Mistinikon Lake and by Sisseney Lake. Both faults separate the Gowganda Formation from the Archean felsic intrusive rocks of the Round Lake batholith. Observations in Powell Township by Dyer (1936) indicate that the strata on the west side of the fault marked by Mistinikon Lake have been displaced approximately 900 m to the south. Movement along the Sisseney Lake fault has been mainly vertical.

Northeast- and northwest-trending joint sets occur in the Gowganda Formation. In the map area, the Gowganda Formation typically strikes northeast and dips gently to the southeast. Significant local deviations from this attitude suggest postdepositional block faulting. North of Yarrow Lake, for example, beds strike east and dip 20° south. Northwest of Elmer Lake beds strike northwest and dip 45° northeast.

Economic Geology

DESCRIPTIONS OF PROPERTIES AND UNCLAIMED PARCELS OF EXPLORED LAND[4, 5]

BAGDAD EXPLORATION ASSOCIATES LIMITED (1)

In 1979, the company held four claims along the gravel road in the area between Elmer Lake and Kame Lake. The area is underlain by metavolcanic and metasedimentary rocks and is thinly mantled by sand and gravel. A geochemical soil survey was performed which reported low gold values but anomalous Ag (>0.6 ppm), Hg (>350 ppb), Cu (98 ppm), Pb (158 ppm) and Zn (200 ppm).

BARKER SYNDICATE (2)

Fifteen claims in northern Yarrow Township (previously known as the Christie claims) were held by the Barker Syndicate of Buffalo, New York. The claims include gold-bearing, sheared, silicified and carbonatized metavolcanic rocks. The showings were examined by W.S. Savage, Resident Geologist, Kirkland Lake, who was informed that samples from trenches had returned assay values of $5.00 over 2.7 m and $18.00 over 2.3 m (US$35 an ounce). A syenite porphyry reported by the previous claim holder, R. Dingle, was not found.

CANADIAN AERO MINERAL SURVEYS LIMITED (3)

In 1963, Canadian Aero Mineral Surveys Limited conducted airborne magnetometer and electromagnetic surveys.

EXTENDER MINERALS OF CANADA LIMITED (4)

The company operates a barite mine on the west shore of Mistinikon Lake and holds four claims adjacent to the mine site (claims 4222, 4223, 4328, 4329). The barite occurs as veins 3 to 5 m in width which strike to the northwest from the fault along Mistinikon Lake. Assay results reported by the company range from 76 to 89 percent barium sulphate.

HARVEY, L. (5)

Exploration, consisting of the excavation of numerous pits and the drilling of one hole, was performed by L. Harvey from 1977 to 1979 on the western and eastern shores of Mistinikon Lake, in southwestern Yarrow Township. The area is underlain by granite and xenolith-bearing gneissic granodiorite, which host numerous chalcopyrite- and pyrite-bearing quartz veins.

TABLE 2. LIST OF PROPERTIES AND UNCLAIMED PARCELS OF EXPLORED LAND IN YARROW AND DOON TOWNSHIPS.
Information from the Assessment Files Research Office, Ontario Geological Survey, Toronto. Date in brackets indicates last year of work.

NAME	TYPE OF WORK
Yarrow Township	
Vandeventer claims [1948]	GR, T
Matarrow Lead Mines Limited [1949]	A, DDH, GR, T
Matarrow Mine [1952]	A, GR, MD
Maralgo Mines Ltd. [1957]	A, DDH
Barker Mining Syndicate/Christie Claims [1964]	A, T
Newmont Exploration of Canada Limited, Amorean Mines Ltd. property [1979]	EM
L. Harvey [1979]	DDH, T
R.B Schaus property	**
Extender Minerals of Canada Limited	A, MD, T
Doon Township	
Canadian Aero Mineral Surveys Limited [1963]	EM
The Coniagas Mines, Limited [1945]	EM, T
Laroma Midlothian Mines Ltd. [1964]	DDH
Bagdad Exploration Associates Limited [1979]	GSS

Abbreviations

A	assay
DDH	diamond-drill holes
EM	electromagnetic survey
GSS	geochemical soil sampling
GR	geological report
MD	mine development
T	trenching
**	inactive due to Teme-Augama Anishnabai native land claim (Bear Island Caution)

LAROMA MIDLOTHIAN MINES LTD. (6)

In 1964, Laroma Midlothian Mines Ltd. drilled one hole to a depth of 121 m in Archean tuffs and syenite porphyry.

MARALGO MINES LTD. (7)

In 1957, Maralgo Mines Ltd. carried out a copper exploration program on four claims in the southeast corner of Yarrow Township. Exploration focussed on chalcopyrite-bearing quartz veins and associated breccias in sedimentary rocks of the Gowganda Formation. Twenty-three holes were drilled totalling 911 m in length. The highest copper value reported was 19 percent, with an average value of < 1 percent.

[4] *Number in parentheses refers to property or occurrence number on Map 2546 (back pocket).*

[5] *Information current to December 31, 1987.*

MATARROW LEAD MINES LIMITED (8)

Thirty-six claims were held by Matarrow Lead Mines Limited in northwestern Yarrow Township, to the east of Mistinikon Lake. The claims were centred on a northeast-trending zone of foliated metavolcanic rocks and banded iron formation. The banded iron formation is 60 m in width and extends for 2 km along strike. It hosts sphalerite- and galena-bearing carbonate veins in "veined shatter zones". From 1948 to 1952, 30 holes, totalling 2612 m in length, were drilled along strike.

The mineralization was described as follows by company geologist E.K. Fockler:

> The vein matter consists usually of altered, well-fractured, soft, chloritic material and contained calcite veining and galena-sphalerite mineralization. The vein proper frequently is characterized by a central replacement band, from one to two feet in width, of relatively massive, finely crystalline galena. Galena is also noted on fractures and in calcite seams over widths of three feet or more on either side of the main mineralization. Sphalerite tends to be largely disseminated through the more siliceous or cherty material on either side of the main galena mineralization although seams, stringers and clusters of massive sphalerite are associated with the galena.

Assay results from drilling and trenching along an 800 foot (240 m) strike length returned average values of 6.73 percent lead and 2.56 percent zinc over a core length of 8.3 feet (2.5 m).

MATARROW MINE (9)

The area around the Matarrow Mine had been explored for lead and zinc as early as 1928, when it was known as the Robb Option. By 1951, underground development had begun, based on drilling performed in the winter of 1948–1949 (*see* Matarrow Lead Mines Limited). The drilling had intersected two roughly parallel carbonate veins dipping steeply to the south. A three compartment shaft was begun and sunk to a depth of 57 m. A total of 172 m of drifting was then performed. Ore sections totalling 145 m in length averaged 9.3 percent lead and 4.3 percent zinc over a sample width of 1.4 m. The ore reserves were estimated to be 28 000 tons grading approximately 7.5 percent lead and 3.5 percent zinc. In 1951, control of the mine was assumed by Matachewan Consolidated Mines Limited. Poor ore grades at lower levels forced the closing of the mine after the mining of level 1 in 1953.

SCHAUS, R.B., CLARK, D.L. AND SHIRRIFF, J.F. (10)

Magnetometer and VLF electromagnetic surveys were performed in 1979 by Newmont Exploration of Canada Limited on a group of eight claims held by Amorcan Mines Ltd. The property is underlain by gold-bearing, sheared, silicified and carbonatized metavolcanic rocks and is part of the claim group previously held by the Barker Syndicate. The exploration program was to have included mapping and sampling. The area, however, was included in the Bear Island Caution in 1979. This property is now part of a claim group (claims 29666 to 29672 inclusive, 29675, 29676) held by R.B. Schaus, D.L. Clark and J.F. Shirriff.

THE CONIAGAS MINES, LIMITED (11)

In 1945, the company held 15 claims in west-central Doon Township. Geomagnetic surveys delineated a northeast-trending anomaly (700 to 900 gammas) which was coincident with sheared, carbonatized and silicified metavolcanic rocks. Another anomaly was produced by a north-trending cross-fault. Minor trenching was performed.

VANDEVENTER CLAIMS (12)

Twelve claims were held by L. Campbell in north-central Yarrow Township. The claims lay to the east of a small unnamed lake 1.5 km southeast of the junction of the main road and a logging road. They surround a quartz vein system which occupies a northeasterly trending fault zone. In 1940, a consulting geologist's report described the veins as representing a potential low-grade gold deposit, although no assay values were reported. The quartz veins are up to 12 m wide and contain chalcopyrite, pyrite, galena and specularite. Also present are northeast-trending syenite porphyry dikes. The fault zone lies within the mafic xenolith-bearing zone of the gneissic granodiorite of the Round Lake batholith.

RECOMMENDATIONS FOR EXPLORATION

ARCHEAN INLIERS

Although economic concentrations of gold have not yet been found in Yarrow or Doon townships, the area warrants future exploration. The Archean metavolcanic rocks have been affected by shearing associated with the intrusion of the Round Lake batholith. In addition, the westerly extension of the Kirkland Lake–Larder Lake fault zone may lie immediately north of the map area in Powell and Cairo townships.

An assayed sample of carbonatized, intermediate metavolcanic rock from north-central Yarrow Township yielded a gold content of 660 ppb. A grab sample of brecciated, quartz-veined, banded iron formation was taken from an old pit in felsic intrusive rocks to the south of the bridge over Mistinikon Lake. The sample returned an assay value of 300 ppb gold.

Two past producers of gold are located adjacent to the map area: the Young–Davidson Mine in Powell Township and the Stairs Mine in Midlothian Township. The latter is currently being re-evaluated by Goldteck Exploration Ltd.

HURONIAN SUPERGROUP

The Huronian Supergroup has recently been studied for its potential to host Witwatersrand-type paleoplacer gold deposits (Colvine 1981; Long and Leslie 1982; Mossman and Harron 1984). The favourable sites for such

concentrations are in the deposits of braided streams in an alluvial fan setting (Mossman and Harron 1984) and possibly in glaciofluvial outwash deposits (Long and Leslie 1982). Fluvial and glaciofluvial strata were not observed in the course of this study and hence the prospects for placer gold concentrations in Yarrow and Doon townships are poor.

A sample of coarse-grained feldspathic litharenite from strata of the Gowganda Formation, exposed along the roadcut west of Mistinikon Lake, returned an assay value of 21 ppb gold. These strata are interpreted to be the deposits of a proglacial subaqueous outwash fan (Knightly 1987).

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Appendix
Geochemistry of Major Rock Types

The reconnaissance nature of this work does not allow a detailed study of the geochemistry of the rock types in the map area; however, chemical analysis of representative samples was performed. The results of this analysis are presented in the following appendix for the information of the reader and possible future evaluation.

TABLE A1. METAVOLCANIC ROCKS

MAJOR OXIDE LISTING	-0009*	-0020	-0021	-0022	-0023	-0024	-0030	-0022D	-0030D
SiO_2 (wt %)	51.40	67.80	48.40	57.80	47.80	56.50	70.70	58.10	70.50
Al_2O_3	10.30	14.50	15.00	13.90	94.10	12.30	14.90	13.90	14.90
Fe_2O_3	2.53	2.77	2.48	1.80	7.87	3.53	1.33	1.90	1.39
FeO	6.19	2.06	8.39	9.52	6.06	3.33	1.66	9.45	1.66
MgO	13.30	2.96	8.86	2.74	13.20	3.02	0.93	2.78	0.88
CaO	8.64	0.89	10.60	2.42	2.97	6.88	1.62	2.43	1.60
Na_2O	1.87	0.24	1.63	3.34	00.00	3.52	6.07	3.48	5.87
K_2O	1.13	3.31	0.07	0.48	0.02	1.33	0.67	0.47	0.66
TiO_2	0.59	0.19	0.78	1.43	0.64	0.56	0.30	1.38	0.31
P_2O_5	0.26	0.05	0.03	0.13	0.04	0.06	0.05	0.12	0.04
MnO	0.16	0.09	0.18	0.18	0.22	0.09	0.05	0.18	0.05
CO_2	0.34	0.09	0.12	2.31	4.02	5.11	0.11	2.29	0.13
S	0.01	1.60	0.03	0.02	0.01	2.12	0.01	0.02	0.01
H_2O^+	2.45	2.71	3.18	3.25	6.51	2.11	1.14	3.41	1.05
H_2O^-	0.00	0.19	0.00	0.11	0.01	0.07	0.16	0.14	0.07
LOI	2.30	3.80	3.00	4.70	10.70	7.40	1.30	4.80	1.20
TOTAL	99.20	99.40	99.70	99.40	98.80	100.50	99.70	100.00	99.10
SG	2.93	2.78	3.03	2.70	2.51	2.77	2.68	2.70	2.60
TRACE ELEMENT LISTING**	**-0009**	**-0020**	**-0021**	**-0022**	**-0023**	**-0024**	**-0030**	**-0022D**	**-0030D**
Be (ppm)	-1	1	-1	-1	-1	1	-1	-1	-1
Co	44	15	40	34	79	24	10	34	10
Cu	28	166	60	59	187	42	6	61	5
Mo	10	-10	10	10	-10	-10	-10	-10	10
Ni	280	11	142	57	486	74	10	56	9
Sc	30	3	29	24	33	13	4	29	4
Sr	228	25	93	20	9	302	213	22	215
V	181	16	253	288	177	121	38	284	36
Y	14	-5	10	9	-5	5	-5	12	5
Zn	81	116	65	114	70	60	30	118	50
CIPW NORM***	**-0009**	**-0020**	**-0021**	**-0022**	**-0023**	**-0024**	**-0030**	**-0022D**	**-0030D**
APTT (anhydrous	0.6390	0.1248	0.0737	0.3285	0.0548	0.1560	0.1205	0.3018	0.6968
PYRT wt %)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ILMN	1.1627	0.3804	1.5364	2.8972	0.7029	1.1672	0.5797	2.7826	0.6016
ORTH	6.9290	20.6195	0.4290	3.0259	0.0683	8.6253	4.0285	2.9487	3.9854
ALBT	16.4194	2.1409	14.3047	30.1495	0.0000	32.6879	52.2616	31.2632	50.7565
ACMT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ANRT	16.9900	4.3102	34.6457	11.9013	8.3692	15.1814	7.8451	11.9665	7.8441
SPHN	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
RUTL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MGNT	3.8064	4.2339	3.7293	2.7841	6.4989	5.6169	1.9621	2.9247	2.6574
HEMT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DIOP	16.7210	0.0000	10.7318	0.0000	0.0000	13.6371	0.0000	0.0000	0.0000
HEDN	3.7846	0.0000	5.2300	0.0000	0.0000	3.8587	0.0000	0.0000	0.0000
WOLL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENST	26.6198	7.7714	17.9087	7.2797	19.0116	1.9322	2.3567	7.3507	2.2396
FERS	6.9112	1.4210	10.0674	14.9007	2.3007	0.6271	1.5742	14.6930	1.5134
QRTZ	0.0329	49.4888	1.3135	22.6918	11.5576	16.5147	27.8876	22.0242	29.1527
FORS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FAYA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PVSK	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NEPH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LEUC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DICA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
KLPH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CRND	0.0000	9.5131	0.0000	4.0508	51.3383	0.0000	1.3873	3.7537	1.7532
CALC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL	100.0161	100.0039	100.0010	100.0096	100.0028	100.0047	100.0033	100.0090	100.0028
NPLG	50.8638	66.8138	70.7771	28.3022	100.0000	31.7142	13.0520	27.6812	13.3856
FEMG	0.4100	0.0882	0.3255	0.1855	0.2068	0.1025	0.0354	0.1846	0.0338
RMG	0.8360	0.8779	0.7004	0.3910	0.9157	0.8019	0.6630	0.3967	0.6604
RFE	0.1650	0.1221	0.2996	0.6090	0.0843	0.1981	0.3370	0.6033	0.3396
NCI	59.0057	13.8066	49.2374	27.8618	28.6141	26.8394	6.4727	27.7511	6.4140
NORTHING	5304382	5304129	5261909	5302129	5304109	5306541	5305148	5302129	5305148
EASTING	519726	518066	510668	506647	509656	519199	517958	506647	517958
TOWNSHIP	YARROW	YARROW	DOON	DOON	DOON	YARROW	YARROW	DOON	YARROW

* *All sample numbers are abbreviated from the standard OGS sample numbers, e.g., 87RMJ-0009.*
** *Inductively coupled plasma optical emission spectroscopy method.*
*** *See Table A7 for CIPW Norm code key.*

TABLE A2. GRANITES

MAJOR OXIDE LISTING

	-0001*	-0002	-0003	-0004	-0005	-0006	-0007	-0011	-0001D
SiO_2 (wt %)	66.00	55.60	70.90	67.60	74.70	64.70	73.00	68.70	65.80
Al_2O_3	15.80	15.40	14.60	16.40	14.10	16.60	14.90	16.00	15.80
Fe_2O_3	1.35	2.38	0.62	1.73	0.28	1.48	0.47	1.51	1.38
FeO	2.13	4.79	1.06	1.13	0.33	1.93	0.93	1.40	2.06
MgO	1.79	5.43	1.07	0.93	0.22	1.88	0.58	1.29	1.81
CaO	1.92	6.81	1.34	3.28	0.58	2.88	2.28	1.75	1.88
Na_2O	5.73	3.89	5.83	4.87	5.40	5.40	5.24	5.17	5.82
K_2O	2.87	1.47	2.17	1.41	2.70	1.68	0.98	1.63	2.84
TiO_2	0.34	0.65	0.22	0.27	0.01	0.41	0.15	0.29	0.33
P_2O_5	0.16	0.34	0.08	0.09	0.01	0.17	0.04	0.10	0.15
MnO	0.07	0.13	0.03	0.05	0.02	0.06	0.02	0.09	0.07
CO_2	0.21	0.22	0.84	0.11	0.16	0.22	0.19	0.25	0.21
S	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
H_2O^+	0.82	1.48	0.77	1.13	0.39	1.34	0.70	1.15	0.98
H_2O^-	0.00	0.05	0.00	0.00	0.00	0.08	0.09	0.00	0.06
LOI	0.80	1.70	1.50	1.60	0.60	1.40	0.70	1.50	0.90
TOTAL	99.20	98.70	99.50	99.00	98.90	98.80	99.60	99.30	99.20
SG	2.68	2.84	2.61	2.72	2.57	2.71	2.66	2.68	2.68

TRACE ELEMENT LISTING**

	-0001	-0002	-0003	-0004	-0005	-0006	-0007	-0011	-0001D
Be (ppm)	1	1	-1	-1	-1	1	-1	-1	1
Co	9	24	-5	6	-5	9	-5	7	8
Cu	7	79	-5	20	-5	5	16	9	7
Mo	-10	-10	-10	-10	-10	-10	-10	-10	-10
Ni	19	74	7	6	-5	21	-5	7	18
So	5	15	3	3	-2	6	2	4	5
Sr	520	752	189	342	298	617	358	378	504
V	58	172	22	32	7	66	13	38	58
Y	7	13	-5	-5	-5	-5	-5	-5	6
Zn	54	89	30	47	11	69	37	105	55

CIPW NORM***

	-0001	-0002	-0003	-0004	-0005	-0006	-0007	-0011	-0001D
APTT (anhydrous	0.3861	0.8312	0.1935	0.2181	0.0241	0.4243	0.0961	0.2419	0.3628
PYRT wt %)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ILMN	0.6678	1.2741	0.4267	0.5245	0.0193	0.8012	0.2890	0.5624	0.6399
ORTH	17.2775	8.9655	13.0955	8.5230	16.2227	10.2146	5.8739	9.8357	17.1353
ALBT	49.3945	33.9726	50.3797	42.1528	46.4599	47.0144	44.9735	44.6718	50.2830
ACMT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ANRT	8.6388	20.8665	6.2552	16.0435	2.8592	13.5580	11.2078	8.1981	8.5223
SPHN	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
RUTL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MGNT	1.9941	3.5615	0.9180	2.5658	0.4128	2.2079	0.6912	2.2356	2.0430
HEMT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DIOP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HEDN	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WOLL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENST	4.5416	10.7983	2.7215	2.3693	0.5571	4.8175	1.4652	3.2807	4.6026
FERS	2.4091	4.7894	1.1507	0.2996	0.4020	1.8067	1.1248	1.0332	2.2748
QRTZ	14.5474	5.5109	24.4393	26.1691	31.7590	18.0754	33.0948	27.0997	14.0505
FORS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FAYA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PVSK	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NEPH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LEUC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DICA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
KLPH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CRND	0.1625	0.0000	0.4245	1.1397	1.2848	1.0998	1.1861	2.8472	0.0947
CALC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL	100.0093	100.0198	100.0046	100.0054	100.0008	100.0098	100.0024	100.0064	100.0088
NPLG	14.8859	38.0504	11.0448	27.5679	5.7974	22.3832	19.9493	15.5062	14.4923
FEMG	0.0635	0.1859	0.0358	0.0259	0.0086	0.0617	0.0231	0.0405	0.0631
RMG	0.7124	0.7477	0.7566	0.9122	0.6455	0.7780	0.6312	0.8067	0.7267
RFE	0.2876	0.2523	0.2434	0.0878	0.3545	0.2220	0.3688	0.1933	0.2733
NCI	9.6026	29.8731	5.2169	5.7592	1.3912	9.6333	3.5701	7.1120	9.5603
NORTHING	5306391	5304536	5298567	5298598	5299905	15299901	5299807	5298972	5306391
EASTING	520342	519622	524983	516295	519637	518432	518432	517666	520342
TOWNSHIP	YARROW	YARROW	YARROW	YARROW	YARROW	YARROW	YARROW	YARROW	YARROW

* *All sample numbers are abbreviated from the standard OGS sample numbers, e.g., 87RMJ-0001.*
** *Inductively coupled plasma optical emission spectroscopy method.*
*** *See Table A7 for CIPW Norm code key.*

TABLE A3. MATACHEWAN DIABASE

MAJOR OXIDE LISTING	-0027*	TRACE ELEMENT LISTING**	-0027
SiO_2 (wt %)	52.10	Be (ppm)	2
Al_2O_3	16.70	Co	38
Fe_2O_3	3.21	Cu	100
FeO	7.19	Mo	10
MgO	3.85	Ni	98
CaO	6.97	Sc	12
Na_2O	4.14	Sr	499
K_2O	1.55	V	183
TiO_2	1.26	Y	14
P_2O_5	0.20	Zn	100
MnO	0.13		
CO_2	0.22		
S	0.06		
H_2O^+	1.51		
H_2O^-	0.00		
LOI	1.50		
TOTAL	99.10		
SG	2.91		

CIPW NORM***

	-0027		-0027
APTT (anhydrous	0.4869	NEPH	0.0000
PYRT wt %)	0.0000	LEUC	0.0000
ILMN	2.4594	DICA	0.0000
ORTH	9.4135	KLPH	0.0000
ALBT	36.0036	CRND	0.0000
ACMT	0.0000	CALC	0.0000
ANRT	0.0280	TOTAL	100.0123
SPHN	0.0000		
RUTL	0.0000	NPLG	39.0096
MGNT	4.7033	FEMG	0.1660
HEMT	0.0000	RMG	0.5912
DIOP	5.1390	RFE	0.4088
HEDN	4.0707	NCI	30.7139
WOLL	0.0000		
ENST	7.4721	NORTHING	5299742
FERS	6.7893	EASTING	517040
QRTZ	0.3664	TOWNSHIP	YARROW
FORS	0.0000		
FAYA	0.0000		
PVSK	0.0000		

* *All sample numbers are abbreviated from the standard OGS sample numbers, e.g., 87RMJ-0027.*
** *Inductively coupled plasma optical emission spectroscopy method.*
*** *See Table A7 for CIPW Norm code key.*

TABLE A4. GOWGANDA SANDSTONE

MAJOR OXIDE LISTING

	-0012*	-0013	-0014	-0015	-0016	-0017	-0018	-0019
SiO_2 (wt %)	73.20	71.30	80.50	60.80	62.60	65.50	61.50	81.30
Al_2O_3	11.40	13.70	11.00	16.40	17.20	15.50	16.90	10.40
Fe_2O_3	0.25	0.68	0.00	1.95	1.24	1.02	1.52	0.17
FeO	1.00	2.00	0.47	4.86	3.53	3.73	4.19	0.33
MgO	0.64	1.22	0.41	2.64	2.26	2.24	2.94	0.21
CaO	3.09	0.63	0.24	1.09	1.07	1.25	1.22	0.32
Na_2O	5.23	4.07	5.85	3.75	5.27	4.36	3.65	5.57
K_2O	1.55	3.97	0.08	3.34	3.45	2.90	3.41	0.08
TiO_2	0.19	0.20	0.15	0.47	0.32	0.42	0.50	0.09
P_2O_5	0.04	0.05	0.03	0.12	0.13	0.14	0.14	0.02
MnO	0.05	0.04	0.01	0.07	0.07	0.07	0.07	0.01
CO_2	2.51	0.28	0.13	0.12	0.08	0.09	0.08	0.22
S	0.07	0.05	0.02	0.04	0.05	0.08	0.06	0.04
H_2O^+	0.55	1.00	0.37	2.69	1.33	1.70	2.29	0.28
H_2O^-	0.00	0.06	0.05	0.10	0.00	0.00	0.11	0.00
LOI	2.30	1.20	0.40	2.40	1.70	1.40	2.50	0.40
TOTAL	99.80	99.30	99.30	98.50	98.60	99.00	98.50	99.00
SG	2.64	2.64	2.63	2.74	2.67	2.70	2.72	2.61

TRACE ELEMENT LISTING**

	-0012	-0013	-0014	-0015	-0016	-0017	-0018	-0019
Be (ppm)	-1	1	-1	2	2	2	2	-1
Co	5	7	-5	19	14	16	16	-5
Cu	44	200	5	11	10	49	40	74
Mo	-10	-10	-10	-10	-10	-10	-10	-10
Ni	10	24	-5	61	46	50	55	-5
Sc	6	5	2	8	7	9	8	2
Sr	106	131	35	161	712	221	199	31
V	26	49	12	105	72	84	94	13
Y	11	5	7	8	6	8	8	-5
Zn	10	26	7	62	66	69	65	5

CIPW NORM***

	-0012	-0013	-0014	-0015	-0016	-0017	-0018	-0019
APTT (anhydrous	0.0980	0.1210	0.0720	0.2977	0.3170	0.3414	0.3453	0.0481
PYRT wt %)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ILMN	0.3734	0.3881	0.2885	0.9348	0.6256	0.8212	0.9888	0.1735
ORTH	9.4778	23.9728	0.4788	20.6691	20.9872	17.6432	10.9815	0.4799
ALBT	45.7935	35.1923	50.1327	33.2301	45.9062	37.9832	32.1588	47.8495
ACMT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ANRT	3.1581	2.8600	1.0073	4.8419	4.5902	5.4428	5.3496	1.4790
SPHN	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
RUTL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MGNT	0.3751	1.0075	0.0000	2.9608	1.8508	1.5226	2.2947	0.2502
HEMT	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DIOP	3.5577	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HEDN	2.7418	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WOLL	1.9995	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENST	0.0000	3.1049	1.0341	6.8855	5.7943	5.7436	7.6240	0.5310
FERS	0.0000	2.9174	0.6421	6.9824	5.2084	5.6042	5.9797	0.3406
QRTZ	32.4279	28.7205	45.4093	18.0513	11.4728	21.5589	18.7450	48.2235
FORS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FAYA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PVSK	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NEPH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LEUC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DICA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
KLPH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CRND	0.0000	1.7186	0.9369	5.1538	3.2552	3.3472	5.5411	0.6257
CALC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL	100.0028	100.0032	100.0017	100.0074	100.0078	100.0084	100.0085	100.0012
NPLG	6.4515	7.5159	1.9698	12.7177	9.0902	12.5335	14.2624	2.9983
FEMG	0.0275	0.0530	0.0152	0.1215	0.0972	0.0997	0.1213	0.0079
RMG	0.5978	0.5831	0.6791	0.5644	0.5938	0.5739	0.6262	0.6720
RFE	0.4022	0.4169	0.3209	0.4356	0.4062	0.4261	0.3738	0.3290
NCI	7.0480	7.4179	1.9647	17.7635	13.4792	13.6917	16.8072	1.2954
NORTHING	5304837	5304211	5299888	5304204	5304514	5301584	5300413	5305611
EASTING	517336	513808	513357	510694	511212	513129	513755	517957
TOWNSHIP	YARROW	DOON	DOON	DOON	DOON	DOON	DOON	YARROW

* *All sample numbers are abbreviated from the standard OGS sample numbers, e.g., 87RMJ-0012.*
** *Inductively coupled plasma optical emission spectroscopy method.*
*** *See Table A7 for CIPW Norm code key.*

TABLE A5. NIPISSING DIABASE.

MAJOR OXIDE LISTING	-0025*	-0026	-0028
SiO_2 (wt %)	50.80	50.80	45.60
Al_2O_3	16.00	14.20	12.50
Fe_2O_3	2.02	3.40	6.50
FeO	6.79	9.52	12.10
MgO	7.54	5.58	4.19
CaO	9.17	8.10	10.00
Na_2O	1.42	2.45	2.45
K_2O	2.58	1.80	0.12
TiO_2	0.51	1.13	2.54
P_2O_5	0.02	0.13	0.16
MnO	0.17	0.22	0.26
$C0_2$	0.75	0.18	0.43
S	0.08	0.11	0.01
H_2O^+	1.83	1.99	2.75
H_2O^-	0.05	0.22	0.19
LOI	2.70	1.70	2.50
TOTAL	99.70	99.80	99.80
SG	2.97	3.02	3.12
TRACE ELEMENT LISTING**			
	-0025	-0026	-0028
Be (ppm)	-1	1	2
Co	36	41	41
Cu	129	136	29
Mo	-10	-10	10
Ni	105	75	14
Sc	26	33	37
Sr	62	225	83
V	102	298	187
Y	8	24	29
Zn	66	106	118
CIPW NORM***			
	-0025	-0026	-0028
APTT (anhydrous	0.0488	0.3164	0.3930
PYRT wt %)	0.0000	0.0000	0.0000
ILMN	0.9984	2.2050	5.0031
ORTH	15.7142	10.0285	0.7354
ALBT	12.3847	21.2999	21.5010
ACMT	0.0000	0.0000	0.0000
ANRT	30.5750	23.0479	23.6003
SPHN	0.0000	0.0000	0.0000
RUTL	0.0000	0.0000	0.0000
MGNT	3.0188	5.0649	9.7745
HEMT	0.0000	0.0000	0.0000
DIOP	8.8925	7.8424	10.6409
HEDN	4.2413	6.5018	11.6797
WOLL	0.0000	0.0000	0.0000
ENST	15.2328	10.6426	5.8897
FERS	8.3338	10.1209	7.4154
QRTZ	0.5631	2.0395	3.3791
FORS	0.0000	0.0000	0.0000
FAYA	0.0000	0.0000	0.0000
PVSK	0.0000	0.0000	0.0000
NEPH	0.0000	0.0000	0.0000
LEUC	0.0000	0.0000	0.0000
DICA	0.0000	0.0000	0.0000
KLPH	0.0000	0.0000	0.0000
CRND	0.0000	0.0000	0.0000
CALC	0.0000	0.0000	0.0000
TOTAL	100.0033	100.0098	100.0120
NPLG	71.1713	51.9708	52.3274
FEMG	0.2731	0.2451	0.2111
RMG	0.7061	0.5802	0.5107
RFE	0.2939	0.4198	0.4893
NCI	40.7174	42.3776	50.4031
NORTHING	5288837	5306234	5302593
EASTING	523970	519616	507789
TOWNSHIP	YARROW	YARROW	DOON

TABLE A6. MYLONITES.

MAJOR OXIDE LISTING	-0008	-0010
SiO_2 (wt %)	60.20	53.90
Al_2O_3	15.30	18.70
Fe_2O_3	1.54	2.19
FeO	5.06	5.86
MgO	4.68	4.39
CaO	1.06	1.71
Na_2O	4.34	3.84
K_2O	1.70	4.03
TiO_2	0.53	0.84
P_2O_5	0.19	0.28
MnO	0.11	0.12
CO_2	0.14	0.39
S	0.01	0.09
H_2O^+	2.93	3.38
H_2O^-	0.22	0.00
LOI	2.90	3.30
TOTAL	98.80	99.60
SG	2.70	2.74
TRACE ELEMENT LISTING		
	-0008	-0010
Be (ppm)	2	3
Co	24	27
Cu	7	16
Mo	-10	10
Ni	172	89
Sc	11	15
Sr	220	203
V	103	142
Y	5	17
Zn	142	120
CIPW NORM		
	-0008	-0010
APTT (anhydrous	0.4712	0.6918
PYRT wt %)	0.0000	0.0000
ILMN	1.0539	1.6642
ORTH	10.5180	24.8429
ALBT	38.4503	33.8963
ACMT	0.0000	0.0000
ANRT	8.3616	6.9414
SPHN	0.0000	0.0000
RUTL	0.0000	0.0000
MGNT	2.3378	3.3124
HEMT	0.0000	0.0000
DIOP	0.0000	0.0000
HEDN	0.0000	0.0000
WOLL	0.0000	0.0000
ENST	12.2036	11.4056
FERS	7.6943	8.1239
QRTZ	15.3681	3.3148
FORS	0.0000	0.0000
FAYA	0.0000	0.0000
PVSK	0.0000	0.0000
NEPH	0.0000	0.0000
LEUC	0.0000	0.0000
DICA	0.0000	0.0000
KLPH	0.0000	0.0000
CRND	3.5530	5.8234
CALC	0.0000	0.0000
TOTAL	100.0117	100.0167
NPLG	17.86.21	16.9975
FEMG	0.1799	0.1752
RMG	0.6758	0.6485
RFE	0.3242	0.3515
NCI	23.2896	24.5061
NORTHING	5300053	5303609
EASTING	517870	519355
TOWNSHIP	YARROW	YARROW

* *All sample numbers are abbreviated from the standard OGS sample numbers, e.g., 87RMJ-0025.*
** *Inductively coupled plasma optical emission spectroscopy method.*
*** *See Table A7 for CIPW Norm code key.*

TABLE A7. CIPW NORM CODE KEY

APTT	apatite	QRTZ	quartz
PYRT	pyrite	FORS	forsterite
ILMN	ilmenite	FAYA	fayalite
ORTH	orthoclase	PVSK	perovskite
ALBT	albite	NEPH	nepheline
ACMT	acmite	LEUC	leucite
ANRT	anorthite	DICA	dicalcium silicate
SPHN	sphene	KLPH	kaliophilite
RUTL	rutile	CRND	corundum
MGNT	magnetite	CALC	calcite
HEMT	hematite		
DIOP	diopside	NPLG	normative plagioclase index
HEDN	hedenbergite	FEMG	FeO + MgO
WOLL	wollastonite	RMG	MgO/FEMG
ENST	enstatite	RFE	FeO/FEMG
FERS	ferrosilite	NCI	normative colour index

MAPS
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